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CONTENTS

PAGE

EFFECT OF CLIMATE ON THE PERFORMANCE OF GRAPES IN MICHIGAN: SOME 1945 OBSERVATIONS ..... *By R. E. Loree* 173

PERCENTAGE OF EDIBLE MEAT IN RELATION TO MEAT TYPE SCORE OF CHICKENS ..... *By Earl W. Henderson* 176

THE SAWMILL SCALE (INDEX) BOARD ..... *By Richard C. Johnson* 181

THE MACOUN APPLE ..... *By Walter Toenjes* 189

ONE YEAR'S RESULTS FROM DUSTING SNAP BEANS TO CONTROL ANTHRACNOSE AND LEAF HOPPERS ..... *By E. H. Bjornseth* 191

EFFECTS OF DDT ON CABBAGE MAGGOT OF RADISH AND ON ASTER YELLOWS AND THE LEAF HOPPER OF HEAD LETTUCE: A PROGRESS REPORT ..... *By Perry H. Bowser* 194

OIL SPRAYS FOR THE CONTROL OF WEEDS IN CARROTS AND RELATED CROPS ..... *By Buford H. Grigsby* 201

FACTORS AFFECTING FARM HORSE POWER ..... *By R. S. Hudson and Byron Good* 208

USE OF 2, 4-DICHLOROPHENOXYACETIC ACID FOR THE IMPROVEMENT OF GREENHOUSE TOMATO PRODUCTION ..... *By M. C. Strong* 216

DUST FUNGICIDES VERSUS FORMALDEHYDE IN THE CONTROL OF ONION SMUT ..... *By Ray Nelson* 226

JOURNAL ARTICLE ABSTRACTS 248

V. R. GARDNER, *Director* - - - - - - - - J. G. DUNCAN, *Editor*

THE QUARTERLY BULLETIN

The Quarterly Bulletin of the Michigan Agricultural Experiment Station is issued in February, May, August and November. It presents: (1) progress reports on long-term major research projects; (2) final reports on short-term projects and (3) short, timely articles of a popular nature that bring together information from various sources on subjects in which farmers are interested.

EFFECT OF CLIMATE ON THE PERFORMANCE OF GRAPES IN MICHIGAN: SOME 1945 OBSERVATIONS

By R. E. LOREE
SECTION OF HORTICULTURE

THE YEAR OF 1945 will undoubtedly be recorded as one of the most unfavorable seasons for fruit production in Michigan. Temperatures above normal during March and April, followed by cool rainy weather and heavy frosts in May, caused severe damage to most fruit crops. At East Lansing apples and pears were most severely damaged. A few plums of some varieties and a light crop of cherries, peaches, grapes, and berry fruits were harvested.

In the variety vineyard the growth of the vines was well advanced at the time of the last frost on May 11 and all of the primary shoots were destroyed. It was observed that some varieties seemed to recover more rapidly than others and the size and quality of the crop borne from the secondary shoots varied considerably with the variety. All varieties produced some fruit, but with some the clusters were small and scattering while others set and matured a fair crop of well filled clusters. An effort has been made to indicate the behavior of some of the more common varieties in the following table:

TABLE 1—*Size of crop, maturity at harvest, and quality of fruit of certain grape varieties at East Lansing, 1945.*

Variety	Size of crop	Maturity at harvest	Quality of fruit
Agawam	Very light	Did not mature	Poor
Brighton	Medium	Fair	Fair
Campbell Early	Light	Good	Good
Concord	Light	Fair	Fair
Delaware	Medium	Fair	Fair
Fredonia	Medium	Fully mature	Very good
Golden Muscat	Very light	Did not mature	Poor
Moore Early	Very light	Good	Good
Niagara	Fair	Fair	Fair
Ontario	Medium	Fully mature	Very good
Portland	Very light	Fully mature	Very good
Seneca	Very light	Fully mature	Very good
Sheridan	Light	Poor	Poor
Worden	Light	Fair	Good
Van Buren	Light	Fully mature	Very good

ARTICLE 28-21

Those that yielded the most fruit were Fredonia, Brighton, Delaware, Concord and Niagara in the order named. Those that matured fruit of good dessert quality were Fredonia, Moore Early, Campbell Early, Portland, Ontario, Seneca, and Van Buren. Concord and other varieties of its season reached a fair degree of maturity, but the fruit was lacking in sweetness, and, hence, of poor quality for dessert or juice purposes.

U. S. Weather Bureau records show that the length of growing season for 1945 at East Lansing was 145 days. The last frost in spring occurred on May 11 and the first frost in the fall on October 3. The average mean monthly temperature for the five growing months was 61.84° F. From climatological data Partridge* determined that a monthly mean temperature for the months of May to September inclusive of at least 65.5° F. and a growing season of more than 160 days is essential for the commercially successful culture of the Concord. These conditions are generally typical for the better sites in the vicinity of Kalamazoo, St. Joseph and other points in southern Michigan where the Concord is most extensively grown. Where the average mean temperature for the five months is below 63° F., with a growing season not exceeding 160 days, Concords will not prove successful as a commercial crop. Weather Bureau records show that since 1910 there have been seven years at East Lansing with a growing season of less than 150 days and 16 years with a growing season of less than 160 days. There have been six years with a monthly mean temperature for the five growing months of less than 63°F. and 18 years with a monthly mean less than 65° F.

From the foregoing data we may assume that the climate at East Lansing generally is unfavorable for the production of the Concord grape and this is in accordance with the facts. In more favorable years with relatively long growing season and high summer temperatures, particularly during the ripening period, Concord and other varieties of its season will mature a crop of high quality fruit, but in many years the fruit does not ripen properly or if so it is of inferior quality and not desirable for dessert use. On the other hand, the earlier maturing varieties such as Van Buren and Fredonia may be expected to mature a crop of desirable quality practically every year, even under rather unfavorable conditions.

INTERPRETATION

Length of growing season and the amount of summer heat are important factors in grape production and these, as well as other factors,

*Partridge, N. L. Grape Production in Michigan. Mich. Agr. Exp. Sta. Spec. Bul. 121, Feb. 1923. This bulletin is out-of-print. It may be examined in libraries maintaining files of Michigan State College bulletins.

should be considered in the selection of varieties and sites when establishing young vineyards. When selecting varieties the adaptability of a given variety to the climate of the region in which it is to be grown is very essential for successful grape culture. Local climate will vary from site to site in any given locality, depending on elevation and other factors. However, by the use of weather bureau records which are available for most sections of Michigan any prospective grower should be able to determine within reasonable limits what the average length of growing season and mean monthly temperatures are likely to be over a period of years in the general area in which the vineyard is to be located.

If the climate is similar to that which generally prevails at East Lansing, the early-maturing or short-season varieties will be more dependable, although the Concord will ripen satisfactorily in some years. Farther north where the summers are much cooler Concord will seldom, if ever, develop good dessert quality. Farther south where it is somewhat warmer, as at Kalamazoo, St. Joseph and other points in the grape belt, Concord will generally prove successful. However, in these sections, especially on less favorable sites, the planting of such varieties as Fredonia may be profitable because of their earlier ripening season and their ability to mature a crop under more adverse climatic conditions.

Of the short-season varieties which are now offered by nurserymen, the Van Buren and Fredonia blue grapes, and Portland and Ontario green grapes are recommended.

PERCENTAGE OF EDIBLE MEAT IN RELATION TO MEAT TYPE SCORE OF CHICKENS

By EARL W. HENDERSON *
SECTION OF POULTRY HUSBANDRY

A SIMPLIFIED SCORING system for estimating meat type of live and dressed chickens was described and illustrated by Henderson (1945). The standards for meat type were based originally on an interpretation of current market standards or popular preferences. A few experiment stations had reported correlations of various measurements with percentage of edible meat, therefore the probable economic value of the system was surmised but publication was not included at that time. Presentation of proof of the economic value of the scoring system is the purpose of this paper.

CRITERIA OF ECONOMIC VALUE

Current market quality standards within an age group of chickens are determined largely by visual means. At least one criterion that influences choice is the relative plump condition of the entire fowl, especially the breast. The well rounded delicately browned plump breast of a roasted fowl is a familiar illustration in color at holiday time. The amount of waste in the inedible portions of a fowl is another criterion of quality which influences selection. It has been a common assumption in the past that the relative plump appearance of a bird was not only appetizing but associated with a high percentage of choice edible meat. Valid proof of this popular supposition is rather meager, probably because of the difficulty of reducing a somewhat intangible criterion such as "relative plumpness" to precise measurement. In some cases precise measurement has not included perhaps the most important economic criterion (percentage of edible meat) in relation to total live or dressed weight. Maw and Maw (1939) found a significant correlation between the circumference of the tibial muscle and percentage of edible meat. Dolecek, Wilson and Poley (1941) found correlations between several physical measurements most pertinent of which, to this report, were "calculated breast volume" and percentage of edible meat.

*The assistance of J. A. Davidson of the Section of Poultry Husbandry in supervising the rearing and dressing of stock is gratefully acknowledged. Cooking work in this project was supervised by Mrs. Ruth (Carr) Wanty and Miss Helen Baeder of the School of Home Economics.

ARTICLE 28-22

Jaap and Penquite (1938) suggested criteria for "conformation" in market poultry. Bird (1943) correlated "fleshing characteristics" with "total edible portion" and "commercial grading" and proposed a "fleshing index" which he states was "almost perfectly correlated to the actual weight of combined breast and leg muscles which were dissected off the carcasses".

TEST FOR VALIDITY OF THE MEAT TYPE SCORE

It was assumed that the most critical test for validity of the Meat Type Score would be the extent to which it might be associated with the percentage of weight of dressed chicken which could be determined as edible meat.

PROCEDURE

The selection and scoring of the chickens was described by Henderson (1945). In addition to live and dressed meat type score the data from which the percentage of edible meat was determined consisted of the following: 1—weight of the individual birds alive and after dressing, bleeding and picking. 2—the weight of the feet and head (severed approximately 1 inch from the rear of the skull). 3—the heart, liver and gizzard (after cleaning). 4—the weight of the bones obtained after the meat was cooked and the edible portion was removed. The bones were weighed in most cases after air drying for 24 hours or more. The quantity of edible meat was obtained by difference between the weight of dressed bird and the combined weight of the bones and offal. The offal included the head, feet, gullet, crop, intestines (and contents), gall bladder, spleen, and sex organs. The percentage of edible meat was calculated by dividing the quantity of edible meat by the dressed weight of the bird.

The birds were scored when alive and again after "dressing". The dressing operation in this case consisted of the removal of feathers and bleeding. It is well known that the differences in weight of feathers and blood among birds of approximately the same weight and class are not great (perhaps one or two tenths of a pound as a rule); therefore, the dressed weight, alone, was used as the base for calculating the percentage of edible meat. The scores of the live birds were estimated entirely by handling whereas the scores of the dressed birds were estimated by sight. Both live and dressed scores of the birds are compared with the actual average percentages of edible meat in Table 1.

While the percentages of edible meat as determined from the sample group of 48 "roasters" chosen at random from a larger group of birds are shown in Table 1, Fig. 1 should be used as a guide for estimating expectations.

TABLE 1—*Average percentage of edible meat in four meat type score classes.*

Score	1	2	3	4
Live	66.1%	64.8%	64.7%	59.5%
Dressed	65.8	64.5	62.7	58.0

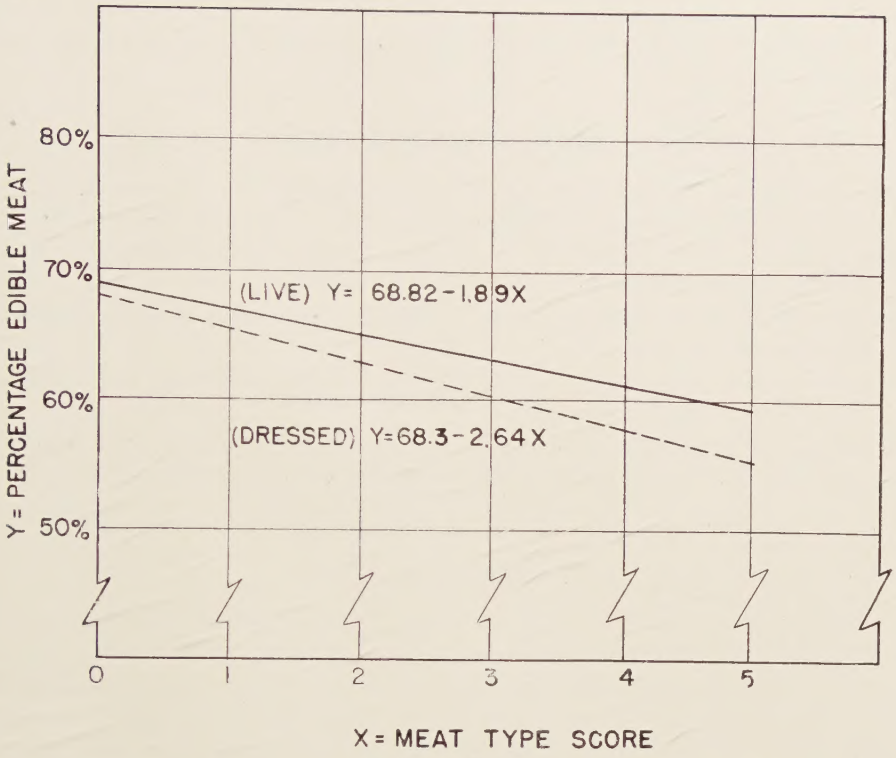
PRACTICAL CONSIDERATIONS

If a poultry breeder wants to improve the meat type or yield of edible meat from individual birds he should select individuals which may be scored "1" or better. He can expect such birds in good condition to yield approximately 66 percent of edible meat (66.9 percent if scored live). A bird which might be found to be actually better than "1" or "0" should yield about 69 percent of edible meat. In some breeds it may not be possible to find such birds but selection can be made from the best available. Bird which can be found which are scored "5" can be expected to yield only 59 percent of edible meat. Even among the supposedly poor meat type breeds numerous individuals may be found which might be scored "3". Improvement by selecting from such a group of birds seems certain to be slow. It would seem more logical to use birds from the highest scoring class for cross breeding and then select for other breed characteristics in succeeding generations, retaining, meanwhile, a high meat type score standard.

CORRELATION BETWEEN PERCENTAGE OF EDIBLE MEAT AND MEAT TYPE SCORE

The average percentage of edible meat for four meat type score categories is indicated in Table 1. It seems obvious from this table that there is a relationship between the meat type score of dressed birds and the percentage of edible meat. The relationship between live meat type score and percentage of edible meat is not obvious. The population of fowls did not include any individuals which were scored 5 and the means of the highest score categories are nearly identical. Nevertheless, the calculation of the correlation coefficient yielded a significant[1] value (–.48). Several individuals which were scored 5 have been met with in other populations of chickens and it is resonable to expect that more extensive application of the scoring system will lead to a more significant correlation. There is close agreement in average percentages of edible meat between the live and dressed score groups in Table 1 because of a very high correlation between live and dressed scores.

[1]Fisher, R. A. 1930. *"Statistical Methods for Research Workers."* Oliver and Boyd, London.



Regression

Fig. 1. Percentage of edible meat on meat type score.

Mathematical proof of the significance of the apparent relationship between meat type score and percentage of edible meat was obtained by calculating the correlation coefficient between the two variables. The correlation between dressed meat type score is high (–.63) and significant.[1] In other words, the lower (better) the meat type score the higher the percentage of edible meat and vice versa. This relationship is shown graphically in Fig. 1.

The correlation between live meat type score is not as high (–.48) but it is significant and high enough to be useful as a criterion for selecting meat type fowl.

SUMMARY

Mathematical proof of a valid relationship between the meat type score of live and dressed chickens and the percentage of edible meat has been presented by means of calculated significant correlation coefficients. The correlation between dressed meat type score (range 1-5)

[1]Fisher, R. A. 1930. *"Statistical Methods for Research Workers."* Oliver and Boyd, London.

and the percentage edible meat is –.62. That for live meat type score is –.48. Selection methods for improving meat type by breeding are included.

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THE SAWMILL SCALE (INDEX) BOARD

By RICHARD C. JOHNSON
SECTION OF FORESTRY

A RESEARCH PROJECT for the improvement of small sawmills was recently initiated at Michigan State College.[1] This article is the first progress report on the project. Other reports will be issued as new developments are completed. Projects planned for the coming months include the development of (1) economical air dogs for small sawmills, (2) automatic rack and pinion adjusters, (3) saw lead indicators and improved lead adjusting equipment, and (4) the adaptation of beam lights for slab and edging cut indicators.

SCALE BOARD

In sawing a log into lumber, a sawyer needs some type of indicator to guide the setting of the log to produce lumber of desired width and thickness without waste. The ordinary type indicator on small mills consists of a ruler either attached to the base of the sliding knee or cast as part of the knee and a pointer fixed to the bunk of the headblock. As the knee is moved forward the ruler moves with it past the fixed pointer to indicate the distance between the face of the knee and the saw.

The term "scale board" is used to describe another type of indicator in which a ruler is attached to or made as part of an upright board, attached to the back side of the carriage. In addition to the ruler, scale boards show the cant width required to subdivide without waste into a series of boards of a given thickness.

The scale (index) board herein described is a modification of existing indexing devices and is an attempt to increase accuracy and versatility of existing equipment. The device is relatively simple and economical to construct. It affords a good starting point for the improvement of small sawmills, especially those producing softwood lumber or custom sawed hardwood lumber for building purposes. It has less application in the sawing of grade hardwood lumber because grade hardwood is usually marketed random width.

[1]The project is jointly sponsored and financed by the Michigan State Planning Commission, the Lake States Forest Experiment Station of the U. S. Forest Service, and the Agricultural Experiment Station of Michigan State College.

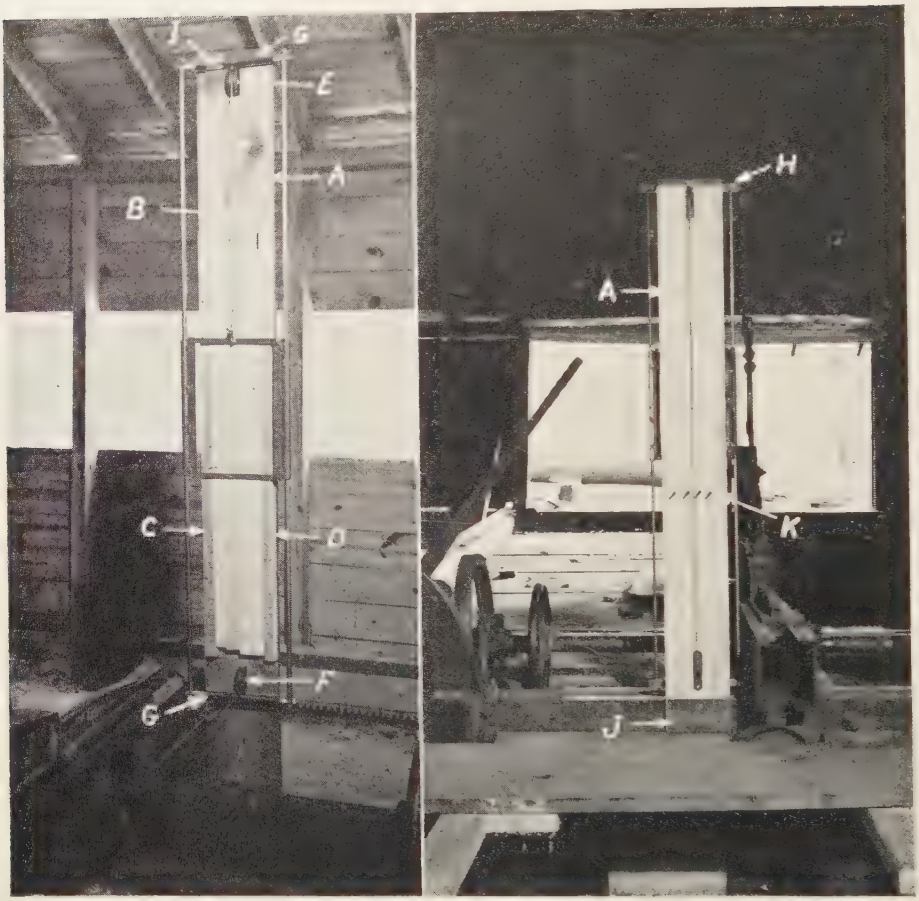

Fig. 1. Overall views of face and back of scale board. (Letters are referred to in the text.)

Some of the improvements over existing models embodied in this index board are:

1. The movement of the index pointer 2 inches for each inch movement of the knee. This is brought about by the pulley ratio as pictured in Fig. 2. This device makes it possible to double the base scale of the index ruler so that the inch marks are actually 2 inches apart (Fig. 1, C, and D). The resulting scales are easier to read and setting can be done more accurately. For the experienced sawyer or the mill with simple indexing problems, a narrow scale board containing just this 2-to-1 ratio ruler might be all that is needed.

2. The tongue and grooved slip sticks between the inch scales are marked to indicate the number of boards of various thicknesses to the knee or to any desired last board thickness. For example, if it is cus-

tomary to leave a 2-inch plank on the carriage on the last cut instead of sawing down to the last inch board, the slip sticks can be moved down to indicate the number of 4/4 or other thicknesses to a 2-inch plank rather than back to the knee. The sticks can be moved down still further to indicate the number of boards to a 4-inch by 4-inch blocking square or any other size material desired to be left on the carriage.

3. The window device detailed in Fig. 3 shows the distance from the face of the knee to the saw. This distance is indicated by the base line near the bottom of the frame (Fig. 3, 0). In addition the positions of several cuts of various thicknesses are predicted in advance by the short lines (Fig. 3, P) above the base line of the window. This is helpful in determining the setting to produce boards down to a standard cant thickness such as 6, 8, 10 or 12 inches. When the cant is turned down and sawed pre-edged lumber of desired width is produced.

4. Both the slip sticks and the glass or celluloid of the window frame are quickly removable to permit insertion of new combinations of lumber thicknesses or saw kerf changes.

HOW TO BUILD THE SCALE BOARD

Following is a step-by-step description of how to build the scale board as pictured in this article.

1. For the base or frame board (Fig. 1, A), use a surfaced four-side

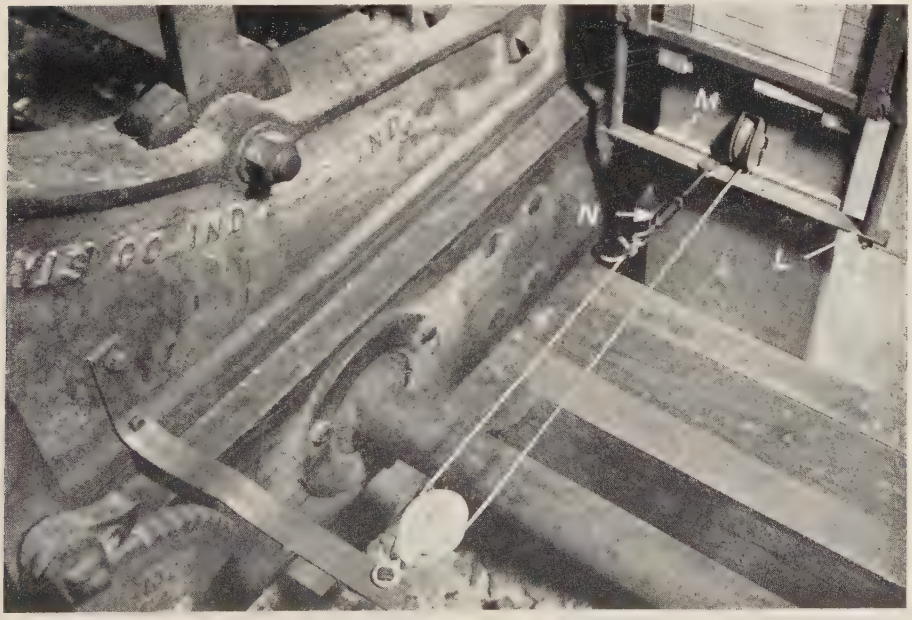

Fig. 2. Detail of cable and pulley installation.

Front View *Rear View*

Fig. 3. Detail of window device.

4/4 inch board, 7½ inches wide by 6 feet long of air-dried non-warping wood.

2. The slip sticks (Fig. 1, B) should be made of light-colored wood such as basswood, pine, or white hard maple. The individual sticks are 1½ inches wide by 40¼ inches long of 4/4 inch lumber surfaced about ¾ inch thick. These sticks are then tongue-and-grooved, the tongue being ¼ inch in both dimensions. The groove should be sufficiently larger to permit easy movement of the tongue in the groove in all types of weather.

3. On the two sticks for the edges of the board (Fig. 1, C and D) lay off the inch scales similar to a ruler except that each space representing an inch should be 2 inches long. Start at the top with 1, since 1 inch is the thinnest last board produced by most mills. The 40¼-inch sticks are then marked off with a lead pencil at 2-inch intervals to the bottom. These marks are numbered as 1, 2, 3 and so on to

21 at the bottom. This scale corresponds to the actual inch movement of the knee because the pulley ratio is 2 to 1. The spaces between these marks are then subdivided into ½'s, ¼'s or even smaller subdivisions if desired. The ruler on each side is used to make it easier and more accurate to jump from the index figures in the center to the inch scale on the nearest side.

4. One of the rulers (Fig. 1, C) is attached with counter-sunk screws to the face of the base board along one edge with the top of the ruler 16 inches below the top of the base board. The other slip sticks are then put in position with the second ruler on the opposite edge. The second ruler (Fig. 1, D) should be pushed against the intermediate slip sticks just enough to permit them to slide easily. In this position square across from the fastened ruler to the ruler on the opposite edge so that the two rulers are lined up across, and then attach the second ruler with countersunk screws to the base board.

5. Cut a slot (Fig. 1, E) in the center of the top of the base board wide enough and long enough to install an ordinary window sash pulley. Dimensions are not given because of the varying size of sash pulleys.

6. Install a second sash pulley (Fig. 1, F) one inch below the bottom of the rulers and in the center of the board.

7. Make the window frame detailed in Fig. 3. The frame is made to hold a glass or sheet of celluloid. A slot is provided in both sides to hold the edges of the window. The window is prevented from sliding out the bottom of the frame by welding the bottom cross brace on the inside of the angle iron (Fig. 3, Q) before welding the ½-inch straps to the side to make the slots. To make the slots, the ½-inch strap irons are held away from the angle iron by inserting tin spacers 1/32 inch thick for celluloid and thicker for glass (Fig. 3, R). The top cross brace (Fig. 3, S) is welded to the outside of the angle iron to permit removal of the window from the top. One-half inch pipe (Fig. 3, T) is welded to the sides of the frame. Since half-inch pipe is actually larger than ½ inch in inside dimensions, ½-inch steel rods fit freely through the pipe, permitting free movement of the window frame up and down.

The parts for the window frame are as follows:

2 pcs. angle iron ⅛ inch by ¾ inch by 13 inches long. (Fig. 3, U).

2 pcs. strap iron, ⅛ inch by ½ inch by 8¾ inches long. (Fig. 3, Q & S).

2 pcs. strap iron ⅛ inch by ½ inch by 12½ inches long. (Fig. 3, V).

2 pcs. ½ inch pipe 13 inches long (Fig. 3, T).

8. Two pieces of ⅛ inch by ¾ inch angle iron 11½ inches long are cut for rod holders (Fig. 1, G). One-half inch holes are drilled in one face of the angle iron to hold the rods (Fig. 2, L). It is important to have the holes the correct distance apart so the window frame will slide up and down without binding. To get the proper hole locations, put the ½-inch rods through the pipes and mark the angle iron when the rods are in place. The rods fit through these holes and are kept from sliding down by running stove bolts (Figs. 1 and 2, H) through the other edge of the angle irons to form bumpers. The rods can be welded in place if desired. A slot (Fig. 1, I) should be cut in the top angle iron to permit one slip stick to pass out the top of the board so the others can be removed when a new set is needed.

9. Shim up the angle iron holders away from the base board until the window frame can slide just free of the slip sticks when the board is upright. A piece of ⅜-inch plywood (Fig. 2, M) was used on the pictured board. Fasten the angle irons in place with screws at top and bottom.

10. On the four center slip sticks mark off the four most common settings used. In the illustration the pencil lines on the first stick (Fig. 3, W) on the left are $1\frac{1}{16}$ inch apart (double scale) which represents the amount the setworks is set to move the knees. With 9/32-inch kerf the boards resulting are 25/32 inch thick. The other columns are marked off at 2 inches, 2¼ inches, and 1¼ inches (double scale). These sets were chosen because they are used considerably in custom sawing farm lumber. They were arranged as they are in Fig. 3 for convenience because the $1\frac{1}{16}$ inch and 2 inches set are used together and 1¼ inch and 2¼ inches are used as a second pair.

11. The window is next marked. Red paint applied with a fine brush or drawing pen makes good lines that are clearly visible over the black lines of the board below. A base line is drawn all the way across first, about ½ inch above the bottom of the glass or celluloid (Fig. 3, O). The frame is then shifted up or down until this base line comes right over any black line about half way down the $1\frac{1}{16}$ inch set column. In this position the black lines on the stick show through the glass to the top of the frame. Red lines are then painted directly over each black line in the column until the top of the glass is reached. The frame is then shifted until the base line is directly over a black line in the 2 inch set column and the red lines painted in this column. The other two columns are completed in the same manner. These window marks above the base line indicate where the knees will be after one or more cuts are made.

12. The completed board is then attached to the rear side of the back timber of the carriage, usually between the first headblock and the setworks (Fig. 1, J). If there is not sufficient room to mount it here it can be mounted in front of the first headblock.

13. Install a 3/32-inch aerial cable or furnace chain as illustrated in Figs. 1 and 2. Where the cable attaches to the base of the board use a small turnbuckle (Fig. 2, N). The turnbuckle is used to make fine adjustments of the index pointer. A screen door brace can be cut down to make a satisfactory turnbuckle.

In attaching the cable pulley to the knee it is absolutely necessary to have the cable run parallel to the headblock and level. If it is not so attached the indicator will be incorrect.

14. Adjust the center slip sticks to the last board size desired. In Fig. 3 the $1\frac{1}{16}$-inch and 2-inch sets are set at 1 23/32 inches (roughly 1¾ inches) last size board because, as explained earlier, they are a common pair in sawing so-called "kerf shy" farm lumber. The 2¼-inch set and the 1¼-inch set sticks are set at 1 31/32 inches (roughly 2 inches) because they constitute another common pair in sawing. The slip sticks are then locked in position either with screws or finishing nails or with window stops installed in the base board (Fig. 1, K). Holes are drilled part way into the back of the slip sticks so the catches of the spring window stops can hold the sticks in place. The window stops take the most time to install but permit the most rapid removal of the sticks as well as adjustment to new last board thicknesses.

Many modifications of this index board are possible to make it more adapted for varying local conditions. A mill sawing all relatively small logs, for example, could reduce the height of the board by indexing only up to 15 inches instead of 21 as illustrated. Six or more slip sticks can be used instead of four between the side rulers if the mill cuts a number of different thicknesses of lumber. The board could be mounted at right angles to face a setter on the carriage by using an extra pulley to turn the cable at right angles before it enters the board.

Small sawmills in general have a bad reputation for sawing inaccurate lumber. This seems especially true of custom sawed farm lumber where accuracy in both thickness and width of lumber is essential for successful use in farm buildings. It should be pointed out, however, that many small mills in Michigan produce good lumber. Unfortunately, the poor mills have caused considerable adverse public opinion toward all small mills and their products.

There are many contributing factors to the production of inaccurate lumber. If a systematic mill improvement program is put into effect

the quality of lumber can be improved very materially. The scale board just described is one improvement which can be used on nearly all small mills to advantage. As suggested earlier it may not be needed in the complete form for experienced sawyers but may consist of just the two-to-one ratio ruler. The double scale ruler facing the sawyer at eye level can be read with considerably more accuracy and speed than the ruler on the knee. Setting to a number, for example, should be increased from a ⅛-inch accuracy to a 1/32-inch accuracy. The vertical scale board will also stay clean, whereas a ruler on the knee accumulates sawdust. The complete scale board should be especially helpful to the new mill operator or the periodic sawyer in speeding up the index settings.

THE MACOUN APPLE

SETS FRUITS IN 1945 UNDER ADVERSE SPRING WEATHER CONDITIONS

By WALTER TOENJES
SECTION OF HORTICULTURE

THE EXTREMELY ADVERSE weather conditions that prevailed in Michigan during the fruit blooming period in 1945, was highly unfavorable for blossom pollination and the set of fruit. On the Graham Station grounds at Grand Rapids apples began to bloom on April 10, fully 4 weeks earlier than normal, and extended to May 21 on which date a few open blossoms still were present on some varieties. During this 42-day interval, bee activity in the apple blossoms was greatly restricted by low temperatures and frequent rainfalls. Also, the effectiveness of the bees was considerably reduced in that the blossoms were often washed free of pollen by heavy and prolonged rains. In most cases where interfertile pollinating varieties were growing in close proximity and adequate bee populations were present in the orchard, a sufficiently large percentage of apple blossoms were successfully pollinated to insure a fair to good set of fruit. Intermittent low temperatures, however, reaching as low as 26° F. on one occasion, killed many of the previously pollinated blossoms, thereby greatly reducing or entirely destroying the fruit set on all but the more cold-resistant varieties.

Although such extreme spring weather conditions occur only rarely in Michigan, nevertheless, freezing temperatures do occasionally kill many apple blossom buds and newly set fruit in certain years. It is during such seasons that apple varieties which set fruit under unfavorable conditions prove of particular value.

It is of interest to note that among the newer apple varieties in the state collection, which set fruit under unfavorable spring weather and proved resistant to blossom and fruit injury by these low temperatures, is the Macoun. This variety set and matured a full crop of fruit in 1945, while most adjacent trees of various old and new apple varieties blooming at the same time, set and matured very little or no fruit. This factor, in addition to the other good qualities this new variety possesses, should make the Macoun of special interest to the apple growers of Michigan.

ARTICLE 28-24

Having McIntosh as one of its parents, the Macoun resembles this popular variety in several respects. In shape the fruit is similar but slightly more elongated. The color is somewhat darker, often becoming very dark red with little or no stripe and with a heavier bloom. The fruit being somewhat firmer than McIntosh bruises less easily. The flesh is white, crisp, tender, juicy and rates equal to or slightly richer in flavor than its parent. It is especially esteemed as a refreshing dessert apple.

At Grand Rapids the Macoun ripens during the first week in October, from 2 to 3 weeks later than McIntosh, and it keeps somewhat longer in storage. As the trees get older the fruit runs a little smaller, and if the trees are permitted to overbear a considerable amount of fruit falls below the 2½-inch grade. Although the Macoun also has the tendency to drop its fruit as it reaches maturity, the variety is not so pronounced in this respect as the McIntosh. Further, its susceptibility to apple scab infection is less.

The Macoun tree is hardy, vigorous and productive though inclined to be biennial in bearing. In habit of growth it is upright and vase-shaped. Observations to date indicate that the variety is quite resistant to fire blight infection. Further, it is late in season of blossoming, so that it offers the possibility of being useful as a pollinizer for other late-blossoming varieties, as Northern Spy and Rome.

Although this new variety has many good qualities to commend it, in addition to its ability to set fruit under adverse spring weather conditions, extensive plantings cannot be recommended at this time. However, it is suggested for trial by commercial apple growers who may be interested in a comparatively sure-cropping, late-maturing, McIntosh-like apple, that will extend the season. For the local and roadside trade the Macoun apple should hold a prominent place and find a ready market because of its attractive appearance and its high cooking and eating qualities.

ONE YEAR'S RESULTS FROM DUSTING SNAP BEANS TO CONTROL ANTHRACNOSE AND LEAF HOPPERS

By E. H. Bjornseth
Section of Horticulture

Anthracnose is a fungous disease that produces rough scabby spots on bean pods and makes them unsalable. It also attacks the stems and leaves but, on these parts of the plant, it is less conspicuous. The disease is seed-borne and also lives over winter on infected plant refuse. As present methods of treating seed are not an effective control measure, it has been necessary to use disease-free seed. Michigan growers have imported seed from the West, where the disease is less prevalent, and have resorted to rotation of crops to secure control.

In recent years there have been several outbreaks of anthracnose, the causes of which were not always easily explained, but it is probable that growers either have become careless in rotating crops or have been using infected seed. In Michigan, the temperature and humidity during the growing season are generally favorable for anthracnose. Some growers use seed that is grown locally, and it is likely to be infected. When this seed is used in an area where beans are intensively grown, it is probable that, under conditions favorable for anthracnose, the infection would spread to plantings that were grown from western seed when itinerant pickers move from field to field.

Fungicide sprays have been used in some states and have been found fairly effective. Bordeaux for several years has been known to give control, while recently a new fungicide (Fermate) has been used with some success.

Leaf hoppers may also cause considerable loss to a crop of snap beans. The habitat for the leaf hopper early in the summer is the hayfield and, after the hay is cut, these insects move to new feeding areas such as a bean field. Flagging or rolling of the leaves is a symptom that shows the presence of a heavy infestation of the insect. Casual evidence indicates that leaf hoppers cause some loss to snap beans, although the extent of this loss has not been determined until now because there have been no effective insecticides to give sufficient control for a comparison. The introduction of DDT made it possible to determine this loss more accurately.

ARTICLE 28-25

Arrangements were made for field trials of DDT and Fermate in an area where snap beans are a major crop and where anthracnose and leaf hoppers have been common problems. One and one-half acres of Black Valentine snap beans were planted May 27 on two plots separated by a drive. The larger plot (45,103 square feet) was used for the application of the dust, while the smaller plot (18,553 square feet) was used as a check.

Four applications of dust were made at weekly intervals starting June 27. The first two applications contained 3 percent DDT, while the third and fourth applications contained 3 percent DDT plus 10 percent Fermate. Each application of dust was made at the rate of 25 to 30 pounds per acre with a 4-row duster. The fourth application was put on after the first picking. These dusts were formulated and prepared by Prof. Ray Hutson, of the Entomology Department, and Dr. J. H. Muncie of the Botany and Plant Pathology Department.

The season was favorable for the crop, and there was no indication of anthracnose on either plot, but the leaf hopper population in this section at the time was heavy. The snap beans were harvested and data on yields secured.

Three pickings of 127.19, 49.22, and 47.04 bushels for a total of 223.45 *bushels per acre were obtained from the dusted plot, whereas only two pickings of 117.17 and 39.63 bushels for a total of 156.8 bushels per acre were obtained from the check plot. See Table 1.

It was evident that the beans on the check plot were injured as shown by the rolling of the margins of the leaves while those that were dusted did not roll and the plants were more vigorous. There was a greater set of pods as shown by the extra picking and the greater yield per picking than was secured from the dusted plot. There was an increase of 8.7 percent for the first picking, and 24.1 percent for the second picking in addition to the extra picking from the dusted plot. This greater set of pods was probably due to a more favorable physi-

TABLE 1—*Yields of snap beans on dusted and check plots.*

Treatment	Yield first picking in *bushels per acre	Yield second picking in *bushels per acre	Yield third picking in *bushels per acre	Yield in bushels per acre
Check plot. No insecticide or fungicide	117.17	39.63	0	156.8
Beans dusted with two applications of 3% DDT followed by two applications of 3% DDT plus 10% Fermate.	127.19	49.22	47.04	223.45

*Snap beans packed 27 pounds per bushel.

ological condition, resulting from the control of the insect which permitted more of the bloom to set. This difference in vigor is also reflected in the difference in yields of 66.65 bushels per acre or an increase of 42.5 percent in yield.

CONCLUSIONS

It is apparent that leaf hoppers cause considerable loss to the early crop of snap beans and that DDT dust, if properly applied, will give control. The Federal Food and Drug Administration have determined the tolerance for the amount of DDT residue that is permitted on vegetables. It is probable, because of the rapid growth of the bean pods, that the amount of toxic residue would be below the tolerance if a 3 percent DDT dust is used and if the dust is applied so that the third application of dust is made a week before the first picking and the fourth application just after the first picking. The cost of the materials in 1945 for the four applications was approximately $15 per acre. On the dusted plot, the yield was increased 66.65 bushels per acre. Early snap beans usually sell at the highest price but, even at average market price, this practice should be economical and profitable for the early crop.

Conditions in 1945 were not favorable for anthracnose, and the fungicidal value of Fermate could not be determined. However, usually late in the summer, conditions may be favorable for the spread of the disease, and it is possible that the use of such a fungicide would be justified.

EFFECTS OF DDT ON CABBAGE MAGGOT OF RADISH AND ON ASTER YELLOWS AND THE LEAF HOPPER OF HEAD LETTUCE: A PROGRESS REPORT

By PERRY H. BOWSER
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THE EXPERIMENTAL WORK which appeared most likely to assist vegetable growers in the Upper Peninsula during 1945 was the problem of controlling two very serious insects. Those two insects, cabbage maggot and six-spotted leaf hopper on head lettuce were present in large numbers during the 1945 garden season. Both insects destroy much edible food, and in the past year there has been no definite method of control. The maggot, a pest on all cruciferae in the upper peninsula, has long been a serious problem, but the leaf hopper in head lettuce fields has been present in serious numbers only during the last three seasons.

Since DDT was announced as the insecticide to use for control of flies and many other insects of house and garden, a plan was originated to try this insecticide on these two most troublesome insects. Professors Ray Hutson and Walter Morofsky of the Entomology Department, Michigan State College, supplied the DDT in three forms: 25-percent wettable powder, 5-percent mixed dust, and 100-percent DDT technical. Their suggestions pertaining to the use of DDT were followed carefully during the season.

MATERIALS

The 25-percent wettable powder was used in two ways—as a dust and as a spray. The spray was prepared by adding one pound of 25-percent wettable powder to 25 gallons of water and mixing thoroughly. The 25-percent wettable powder was applied as a dust also. The 5-percent mixed dust, commercially prepared, was applied as a dust. The 100-percent DDT crystalline material was mixed with cornmeal as a bait for the cabbage maggot, 1 part DDT to 19 parts cornmeal.

CABBAGE MAGGOT (*Hylemia brassica*)

The cabbage maggot is the immature or larval stage of a small insect which resembles the house fly. This insect hatches from an egg laid by the parent fly on or near the stem of the plant at the ground level.

ARTICLE 28-26

The damage to plants arises from the feeding habits of the larval insect (maggot) which tunnels into the root tissues, infecting them with rot. Cabbage, cauliflower, turnip, radish, rape, mustard, and all cultivated plants belonging to the cabbage family are attacked in the same way.*

Each year for the past nine years at the Upper Peninsula Experiment Station, experiments were conducted with radish plots, using various chemicals and home remedies in an attempt to find some method of properly controlling the maggot. Those trials revealed corrosive sublimate to be the only insecticidal agent even partially effective (75-85 percent). Corrosive sublimate is considered too expensive and too difficult to handle by most gardeners; therefore, most crops of the cabbage family are delayed in planting until June 20 to July 1, to avoid the heavy maggot population during the cooler late spring and early summer.

RADISH PLOTS

In order to determine the effect of DDT upon cabbage maggots, a series of radish plots were planted at the Upper Peninsula Experiment Station. The first series of plots were seeded June 1, 1945. Each plot consisted of two adjacent rows, 10 feet in length. The first application of DDT was applied 10 days after complete emergence of seedlings because of delay in obtaining materials. Two more applications were made, one week apart, making a total of three applications on radish. Root counts were made on each plot, and are expressed as percentages of total in Table 1.

The second series of plots were seeded June 11, 1945. Each plot consisted of two adjacent rows 24 feet in length. The DDT dust and

TABLE 1—*Effect of DDT on cabbage maggot, first crop.*

Treatment	Percent of radish roots	
	Maggoty	Maggot-free
A. 25% spray (1 lb. in 25 gal. water)	40	60
B. Check	63	37
C. 25% dust	24	76
D. Check	29	71
E. 5% dust	50	50
F. Check	29	71
G. Bait (100% DDT—1 part to 19 parts cornmeal)	81	19
H Check	90	10

*Ray Hutson. Bean, Cabbage and Onion Maggots. Michigan State College Ext. Bul. 179.

TABLE 2—*Effect of DDT on cabbage maggot, second crop.*

Treatment	Percent of radish roots	
	Maggoty	Maggot-free
A. 25% dust (seed treatment only)	53	47
Check	61	39
B. 25% dust	6	94
Check	70	30
C. 25% spray (1 lb. in 25 gal. water)	80	20
Check	64	36
D. 5% dust (seed treatment only)	22	78
Check	80	20
E. 5% dust	13	87
Check	59	41
F. Bait (100% DDT—1 part to 19 parts cornmeal)	28	72
Check	67	33
G. 25% (seed treatment and dusting 3 times)	5	95
H. 5% (seed treatment and dusting 3 times)	13	87

spray treatments on the row were applied three times. The first applications were made the second day after complete germination, before the first true leaves were evident. The second applications were made one week later, and the third applications were made one week after the second, or, three applications from time of germination, one week apart. Four plots were seed-treated; that is, the radish seeds were dusted with a 25-percent and a 5-percent DDT wettable powder before seeding. Two of those plots were not dusted or sprayed and the other two plots received the three weekly applications. Root counts were made and expressed in Table 2 as percentages of maggots and free of maggots.

Very severe burning of the leaves occurred in the plots dusted with 25-percent DDT wettable powder, and a slight burning was observed in the plots dusted with 5-percent DDT dust mix.

It is evident from these tables that spraying or dusting for control of the cabbage maggot must begin with the emergence of the seedling, and that DDT in certain concentrations applied as a dust gave a better control of the maggot than any treatment previously used at the experiment station. The seed treatment was not effective, and the spray was not effective, but the 25-percent and the 5-percent dusts, applied three times after emergence of seedlings, were effective and show promise of providing relief from the cabbage maggot problem. Apparently 5-percent bait prepared from 100-percent chemical DDT with cornmeal did not give control as well as the prepared dusts. Because of insufficient mixing 100-percent DDT must be milled and prepared in

such a way as to remain in fine particles. The difference in effectiveness between 5-percent and 25-percent dust offers an idea to gardeners that 10-percent DDT dust may be an intermediate concentration more effective than 5 percent and less expensive than 25 percent. This problem of economical concentration will be next in order for experimental planning. At the present time, a 5-percent mix dust handled properly and applied at proper times will give most economical returns.

HEAD LETTUCE—ASTER YELLOWS

The effectiveness of DDT on the leaf hopper *(Macrosteles divisus)* which in turn would demonstrate control of aster yellows in head lettuce was planned around the same general methods and materials as employed in the maggot plots. Dusts and sprays used on four separate crops consisted of 100-percent, 25-percent, and 5-percent DDT. The planting time for the four crops of head lettuce followed the same time schedule and pattern used in previous years at the station and employed by most growers in this northern area. Great Lakes and Imperial 456 were the two varieties of head lettuce used. In the previous two seasons, 1943 and 1944, Great Lakes appeared more susceptible to the aster yellows disease than the general run of Imperial varieties.

First Crop:

Seeds were sown in the greenhouse April 1, plants were field set May 5, and cutting began July 5. Twenty-five heads were included in each plot. The DDT applications were made June 18 and June 25. Head counts were made at the time of cutting to determine the individual heads infected with aster yellows and those free of the disease. These determinations are expressed in Table 3 as percentages for each treatment.

TABLE 3—*Effect of DDT on leaf hopper—aster yellows, first crop.*

Treatment	Percent lettuce heads	
	Yellows	Free of disease
25% dust	12	88
Check	16	84
25% spray (1 lb. of 25%; 25 gal. water)	20	80
Check	32	68
5% dust	20	80
Check	28	72

TABLE 4—*Effect of DDT on leaf hopper—aster yellows, second crop.*

Treatment	Percent lettuce heads	
	Yellows	Free of disease
(Great Lakes)		
25% dust	16	84
25% spray	24	76
25% dust	28	72
5% dust	24	76
25% spray	30	70
Check	44	56
(Imperial 456)		
Check	56	44
25% spray	34	66
5% dust	14	86
25% spray	18	82
25% dust	14	86
25% dust	16	84

The yields of marketable heads of lettuce from DDT-treated plots were greater than those from check or untreated plots, but it should be observed that in most cases the yields in check plots or untreated plots were high. This is characteristic of the first crop or transplanted early planting of head lettuce. The leaf hopper population usually increases at the time of haying season when hayfields are being stripped of grasses. The leaf hoppers then move in large numbers to other host plants, head lettuce being included. The 1945 season was delayed, owing to an adverse early season which delayed cutting by at least 10 days. This 10-day period just prior to cutting was the time of increased hopper movements. Because of the heavy infestation of the leaf hoppers during July and August, many growers in Upper Michigan in the past two years have come to believe that only two crops are profitable—a June crop from early transplants, and a September crop from July seeding.

Second Crop:

This field was direct-seeded May 5, and seedlings thinned to allow 50 heads per plot for DDT treatments. Cutting from this planting began July 19. Three applications of DDT materials were made June 25, July 2 and July 9. Head counts were made at cutting time and expressed in Table 4 as percent of total.

Third Crop:

This field was direct-seeded May 20, and seedlings thinned in the row to allow 50 heads per plot for DDT treatments. Cutting was started August 13. Applications of DDT material were made July 2, July 9,

TABLE 5—*Effect of DDT on leaf hopper—aster yellows, third crop.*

Treatment	Percent lettuce heads	
	Yellows	Free of disease
(Great Lakes)		
25% spray	34	66
25% spray	36	64
25% dust	30	70
25% dust	24	76
5% dust	32	68
5% dust	38	62
Check	60	40
Check	64	36
(Imperial 456)		
25% dust	20	80
25% dust	30	70
Check	60	40
Check	50	50

July 23, and July 30. Head counts were made at time of cutting and are expressed in Table 5 as percent of total.

Fourth Crop:

This crop was direct-seeded July 5, and seedlings thinned in the row to allow 90 heads per plot. Harvest began September 17, two days after the first frost in the fall. Applications of DDT materials were made July 23, July 30, and August 13. Head counts were made at cutting time and are recorded in Table 6 as percent of total.

DISCUSSION

It is evident from these Tables (3-4-5-6) that as the summer season progresses leaf hopper damage increases up to the time of the September harvest. This factor brings out readily the reasons why com-

TABLE 6—*Effect of DDT in the reduction of aster yellows on head lettuce.*

Treatment	Percent head lettuce	
	Yellows	Free of disease
(Imperial 456)		
25% dust (90 heads per plot)	9	91
25% dust (90 heads per plot)	17	83
25% dust (90 heads per plot)	10	90
Check (90 heads per plot)	44	56
Check (60 heads per plot)	36	64
Check (65 heads per plot)	30	70

mercial growers during the years 1943, '44, '45 eliminated summer plantings and intensified on producing the early and late crops.

The greatest yields in each crop were obtained where a DDT 25-percent dust was used. However, reasonably good control was obtained with a 5-percent dust. Higher concentrations are correspondingly more expensive. Furthermore they are likely to result in objectionably high residues.

Other factors worth considering for future experimentation are the time of application, number of applications, and method of application. Observations from this progress report indicate earlier dusting, immediately after thinning of crop, may increase control of the leaf hopper. An increase in the number of applications may be necessary. It seems that the frequency of application, not the concentration of materials, is the most important consideration. From observations made in a commercial planting at Newberry, Mich., on muck soil, it may pay dividends to dust all grass areas and fence rows surrounding the field of lettuce—to prepare a trap area for migrating hoppers.

The Food and Drug Administration, U. S. Department of Agriculture has set up a very low tolerance for DDT on edible products. Therefore, it would be hazardous to use DDT on lettuce, except very early in the season before the marketable portions have developed. Products containing DDT in excess of the allowable tolerance are subject to confiscation and may be harmful if eaten.

OIL SPRAYS FOR THE CONTROL OF WEEDS IN CARROTS AND RELATED CROPS

By BUFORD H. GRIGSBY
Section of Botany

Preliminary experiments in 1944[1] indicated that kerosene and light fuel oils available in Michigan are not sufficiently toxic to be of value as weed control agents in carrot production. However, a report by Lachman[2] suggested the use of certain other petroleum products that are generally available here. Sovasol No. 5 and Sovasol No. 75, the latter diluted with two parts of white kerosene, were shown to give satisfactory weed control and no oily residue was left in the carrots sprayed with Sovasol No. 5.

In order to determine the possibility of applying oil spray control measures to the Michigan carrot crop, plot experiments with various types of oils were made at East Lansing in the 1945 growing season. Tests of certain of these oils were made on commercial carrot acreages in four different locations.

MATERIALS AND METHODS

The plot tests were designed to determine the degree of selectivity of the oils, quantity of oil needed for weed control, the number of applications required and whether undesirable odor or flavor would result from the application of oil. The oil products used were as follows:

Sovasol No. 5	Socony-Vacuum Oil Co.
Stanisol	Standard Oil Co. (Indiana)
Oleum Spirits	Standard Oil Co.
White kerosene	Standard Oil Co.

All oils were applied without dilution. Sprays were applied with a Champion knapsack-type sprayer fitted with a Monarch .059 weed nozzle. This sprayer will develop 90-100 pounds pressure but requires considerable effort on the part of the operator at this pressure. However, a pressure of 60 pounds can be developed and maintained without

[1]Grigsby, Buford H. and Barrons, Keith C. Some New Ideas in Weed Control. Mich. Agr. Exp. Sta. Quart. Bul. *27*: 301-309. 1945.

[2]Lachman, William H. The Use of Oil Sprays as Selective Herbicides for Carrots and Parsnips. Prof. Amer. Soc. Hort. Sci. *45*: 445-448. 1945.

ARTICLE 28-27

undue fatigue to the operator and this pressure was maintained in all plot tests. The rates of application are shown in Table 1. Oil was first applied 10 days after emergence of the carrots and at 2-week intervals thereafter on plots receiving more than one application. Weed counts were made on all plots after the first spraying. Each count, shown in Table 1, represents the number of weeds in a 4-inch strip, 50 feet long. Stand counts of carrots were not made because it was evident that none of the carrot plants had been killed by the oils.

Trials of Stanisol, Sovasol No. 5 and a light fuel oil were made on 10-acre blocks of carrots in the Grant Area. Sovasol No. 5 was used on a 10-acre and on a 25-acre planting at Eaton Rapids. Stanisol was applied to five acres at Baroda. These commercial plantings were sprayed at the rate of 80-100 gallons per acre, with whatever type of spray equipment the grower possessed, in order to determine the cost of this method of carrot weeding under various operating scales. Nozzles that deliver a flat fan-shaped spray were available in all cases.

In addition to these carrot sprayings, Sovasol and Stanisol were applied to parsnips, celery seedbed and transplants, parsley, and dill.

Yield data were secured on the East Lansing trials but are not included in this report because no significant differences between sprayed and unsprayed carrots were found, nor were any differences reported by the commercial growers.

DISCUSSION

Carrots:

In no case were carrots killed by any of the oils used in these experiments. Examination of Table 1 shows that a satisfactory kill of weeds

TABLE 1—*Weed counts in 50 feet of carrot row (4-inch strip).*

Treatment	Weeds not killed by oils								
	Ragweed	Beggar's tick	Lamb's quarters	Purslane	Grasses	Smartweed	Pigweed	Total No. of weeds	Percentage weed kill
Unsprayed, No. 1	50	26	16	62	168	31	231	564	
Sovasol, 100 gal.	12	15	0	0	4	0	0	31	94
Sovasol, 75 gal.	17	10	7	4	6	18	28	60	88
Sovasol, 50 gal.	4	7	5	1	3	3	12	35	93
Stanisol, 100 gal.	0	0	2	0	1	0	12	15	97
Stanisol, 75 gal.	32	40	68	1	12	10	15	173	66
Kerosene, 100 gal.	1	3	15	0	16	6	39	70	86
Oleum Spirits, 100 gal.	2	0	8	0	0	0	10	20	96
Unsprayed, No. 2	9	32	162	0	72	15	43	425	
Unsprayed average	30	29	89	31	120	23	137	494	

Fig. 1. (Upper right): Unsprayed, no cultivation. Note large numbers of smart weed.

(Upper left): Center row cultivated but not sprayed, the two outer rows sprayed with Sovasol and cultivated.

(Lower right): Rows to the left sprayed with Stanisol, 100 gallons; rows to the right unsprayed.

(Lower left): Single unsprayed row to the left. 6 rows to right sprayed with kerosene. 100 gallon hand weeding was required in this plot.

was obtained when 100 gallons per acre of Sovasol No. 5, Stanisol and oleum spirits were applied. Lower rates of application killed a high percentage of the annual weeds, but enough weeds of certain species were left to require some hand weeding. It should be noted that ragweed and beggar's tick were not killed by any oil spray. The data reported for these two weeds represent differences in distribution of these plants in the plots and are not to be considered as differential

killing of these two species. However, most lands on which carrots are grown do not have a heavy infestation of these annual weeds.

The rates of application reported here are based on a complete coverage of both drill and center. Such procedure eliminates one or two wheel-hoe operations and seems to be desirable in most cases. However, on farms where the weed population is low the amount of oil needed can be reduced by adjusting the spray equipment to cover a 6- to 8-inch area, including the carrot row. Such adjustment can be made by changing the height of the spray boom or by using a nozzle with a narrow spray angle and a smaller orifice. Tractor speed may also be altered so that less oil is applied. It seems doubtful, however, that a satisfactory coverage and weed kill can be obtained with less than 50 gallons per acre. The writer believes that growers should not attempt to use less than 75 gallons per acre because of the difficulty in securing uniform coverage with smaller quantities of oil.

The use of kerosene and fuel oil for carrot weeding does not seem to be satisfactory. Hand weeding will be required in addition to the oil spray and the possibility of an oily flavor in the carrots cannot be overlooked. While no residue was found in the cooking tests made this year, there were several reports of "oily" carrots shipped into this state last season.

The cost of weeding carrots with oil depends upon the type of oil used and the quantity required for satisfactory control. Sovasol, Stanisol and oleum spirits cost approximately 18 cents per gallon. Kerosene and fuel oil are about half as expensive but offer no advantage when the cost of the extra hand weeding operations are considered. Using these prices, and not including depreciation charges on equipment, weeding by means of oil sprays can be done for about $20 per acre with power spray equipment. For the grower who uses knapsack sprayers the cost may be $25 per acre but should not exceed this amount. Two men, with a large power sprayer can spray up to three acres per hour, or 20-25 acres per day. One man, with a knapsack sprayer, can spray 1-1½ acres per day.

In order to determine whether any effects of oil spraying could be detected at harvest time samples of sprayed and unsprayed carrots were submitted to the Department of Foods and Nutrition of Michigan State College. Samples from seven treatments, including two unsprayed lots, one of which was infected with carrot yellows, were submitted on five successive days. Each lot was scored, raw and cooked, by a number of individuals. The average scores for each lot are shown in Table 2. Samples were submitted by numbers and the treatments were not known to the persons making the tests.

TABLE 2—*Average taste test scores of sprayed, unsprayed and yellows infected carrots.*[3]

	Treatment						
	Unsprayed	Sovasol 100 gallons		Stanisol 100 gallons		Kerosene 100 gallons	Yellows—Infected (unsprayed)
		1 spraying	3 sprayings	1 spraying	3 sprayings	1 spraying	
Raw carrots							
Color	5.8	6.2	6.0	6.1	6.1	6.0	5.8
Odor	5.7	5.7	5.9	5.6	5.8	5.9	5.7
Flavor	5.4	5.4	5.3	5.3	5.0	5.2	4.9
Texture	5.8	5.7	6.1	5.8	5.7	5.7	5.8
General conclusion	5.4	5.4	5.4	5.3	5.2	5.2	5.1
Cooked carrots							
Color	5.7	5.8	5.8	5.6	5.8	5.7	5.9
Odor	5.9	5.7	5.4	5.5	5.9	6.0	5.2
Flavor	5.3	5.6	5.1	5.3	5.3	5.3	4.9
Texture	5.6	5.6	5.6	5.5	5.8	5.5	5.5
General conclusion	5.3	5.5	5.2	5.2	5.4	5.3	5.0

Maximum possible score = 7.0

[3]These determinations were made under the direction of Dr. Pauline Paul, Department of Foods and Nutrition. The writer wishes to express his appreciation to Dr. Paul for this assistance.

In no case was oily odor or flavor reported, nor were any other undesirable odors or flavors reported. The lowest score was reported for the yellows-infected group. No significant difference was found between the Sovasol, Stanisol and unsprayed lots. A slightly lower score was reported for the kerosene group, and confirms taste tests on the raw carrots made in the field at various times during the season. The poor flavor cannot be classed as an oily flavor, but some factor seems to be lacking in such carrots.

Reports from the growers who cooperated in these experiments also indicate that the quality of the carrots is not affected by Sovasol and Stanisol spray applications.

Parsnips:

Sovasol No. 5 and Stanisol were applied to a small planting of parsnips. Excellent control of weeds was obtained with both oils. The parsnips were sprayed when in the 2-3 leaf stage and again after a 2-week period. The sprayed rows seemed to have somewhat shorter leaf stalks than the unsprayed rows for a period of 6 weeks, but at the end of the season this difference was not evident and no effect upon root development could be found. The unsprayed rows were not hand weeded and the apparent difference in height may have been due to the competition for light between the parsnips and weeds. None of the parsnip leaves was killed and no significance is attached to this observation of leaf stalk differences.

Celery:

A small open-planted celery seedbed was sprayed with Stanisol when the celery plants had two or three true leaves. Chickweed was so abundant in this bed that it would not have been possible to save the celery plants by hand weeding. A single spraying killed all the chickweed, as well as the other annual weeds present, and no injury was apparent on the celery seedlings. These plants were later transplanted and kept free from weeds by means of two sprayings with oil. Hand weeding was not done, injury was not evident, and at harvest time the celery was of excellent quality, without any trace of oily flavor.

Similar results were obtained with parsley and dill.

When it became apparent that Sovasol No. 5 and Stanisol could be used for weed control purposes in carrots and related crops, one of the major oil refining concerns was consulted for information as to the nature of the products and their availability in Michigan. Both of these oils, as well as oleum spirits and mineral spirits, are in a group known to the industry as the naphthas, and all the petroleum refining concerns produce this group of oils under a variety of trade names. While there are some differences in the physical constants of the members of this group of compounds, all the naphtha-like products having a flash point of 100-110, regardless of trade name, are enough alike to be of value as weed control materials for carrots, parsnips, and related plants.

SUMMARY AND RECOMMENDATIONS

Stanisol, Sovasol, oleum spirits and related oils can be used to give a 95-percent kill of annual weeds and grasses in carrots. The leaves of perennial weeds, such as Canada thistle, nettle and milkweed, may be killed but these plants will recover. Ragweed and beggar's tick, although annual plants, are not killed at any stage of growth. Oil sprays, even though they kill many weeds, will not eradicate all the weeds in a carrot or parsnip planting. However, on many farms these materials can be used to reduce the amount of hand labor needed for the production of these crops to a small fraction of what is generally required.

Carrot plants are not usually injured at any stage of growth by these oils. However, some tip burn may occur if the oils are applied when young carrots are wet with rain or dew. Rain following spraying will have no effect upon the carrots or weed kill. The ideal time to spray seems to be when both carrots and weeds are small. Warm dry weather, while speeding up the weed kill, is not essential. Excellent weed control has been obtained on carrots planted early in the spring and sprayed in cool, wet weather. Weed killing is rapid and results are evident within a few hours after spraying, and susceptible plants are all killed within 24 hours.

Kerosene and light fuel oils, while less expensive per unit than the naphthas, do not give as satisfactory control of weeds as the latter and may produce undesirable flavors in the carrots.

Oil spraying should be done when the carrots are in the 2-3 "fern" stage of growth, and if a second application is needed it can be applied at any time in the following 4-6 weeks. Bunching carrots probably should not receive more than one oil spray and at least 4 weeks time should elapse between spray application and harvest. Early spraying will require less oil for complete coverage of weed foliage but late germination of weed seeds may make it desirable to apply a second spray. Annual weeds can be killed at anytime prior to the flowering stage but are killed most readily when they have not more than 2-4 leaves.

The following recommendations are suggested for those carrot growers whose weeding costs now exceed $25 per acre:

1. Stanisol, Sovasol No. 5, or other trade name napthas with a flash point within the range of 100-110, can be used to control weeds in carrots and related crops.
2. Carrots may be sprayed at any stage of growth but spraying should be done while the weeds are small.
3. Oil spraying is not advisable if hand weeding can be done for $20 per acre or less.
4. Perennial weeds, ragweed and beggar's tick cannot be killed with oil sprays.
5. The rate of application depends upon the method used. 75-100 gallons per acre of *sprayed area* will give satisfactory control.
6. The use of nozzles that produce a flat fan-shaped spray will give best results.
7. Oils should not be applied when young carrot leaves are wet.
8. At least 4 weeks should elapse between spraying and the expected harvest time.
9. Kerosene and fuel oils do not give satisfactory control of weeds.
10. While the naphthas are not explosive in open air, they are inflammable and must be stored in *red-painted* barrels or cans.

FACTORS AFFECTING FARM HORSE POWER

By R. S. HUDSON and BYRON GOOD
SECTION OF ANIMAL HUSBANDRY

THE WAR IS over, and the farmer and horse breeder are wondering, among other things, what kind of a horse will have the greatest usefulness under the changed conditions. They realize the need for greater economy in growing horses since work horses are low in price and used only part time on many farms and on others not at all. Shortage of help and more complete mechanization are bringing about rapid changes, and no one knows just how these factors, coupled with financial conditions, will affect the horse industry.

Associations promoting some of the breeds of light legged horses have claimed for years that a cross-bred horse which could carry a saddle and also do farm work will be the answer; others that a lightweight Percheron or Belgian will be ideal; some insist on the heavy drafters and others think there will be no need for a work horse of any kind on the farm. It is with some of these predictions in mind that Michigan State College some time ago decided to give some variety to the horse breeding program which had been carried on for years on the College Farm. In addition to the breeding of good draft horses of the Percheron and Belgian breeds, studies were planned along two special lines.

First, lower costs in producing horses of light and heavy types through the use of grass, with elimination of grain, chore labor, and housing.

Second, cross-breeding draft mares with stallions of some of the light-legged breeds to produce a horse for comparison with draft horses on the basis of size, adaptability to general farm work and finally the market demand.

The initial step for studying economy in raising the different types of horses was taken in the fall of 1939 when 28 foals of medium and heavyweight breeding were purchased. As indicated in Table 1, half of these foals were of Belgian and half of Percheron breeding. All were grade individuals by purebred sires. Numbers 1 to 20 inclusive were fed weighed amounts of hay and grain each of the three winters.

ARTICLE 28-28

As weanlings they received 1 pound of grain and 1 pound of hay per 100 pounds of live weight daily. The second winter they received ⅓ pound of grain and 1¾ pounds of hay daily per cwt. The third winter they received ½ to ¾ pound of grain and 1 to 1½ pounds of hay per cwt. daily. The grain was one-half ear corn and one-half oats by weight. They were turned out in a field adjacent to the stable each day for exercise during the first two winters. During the third winter, as rising three-year-olds, they were kept outdoors all the time except when feeding. All of the 26 individuals were pastured together each summer.

Numbers 21 to 26 were allowed no grain but were given access to stacked hay and uncut meadows each winter. Compared with the others, they consumed more hay, but no labor or housing was required in caring for them during the winter. These colts did not gain in flesh

TABLE 1—*Weights, sale price and feed fed*

No.	Breeder	Weight Nov. 13, 1939	Weight Mar. 2, 1942	Sale Price Apr. 8, 1942	Dry Feed Fed Nov. 15, 1939-Feb. 28, 1942	
					Hay	Grain
		pounds	*pounds*		*pounds*	*pounds*
HEAVYWEIGHT PERCHERONS						
1	Schulze	538	1,591	$130.00	5,514	2,600
2	Davis	750	1,608	150.00	5,797	2,953
3	Tenny	526	1,545	120.00	5,397	2,544
4	Foster	661	1,668	125.00*	6,397	2,962
5	Price	769	1,501	155.00*	5,819	2,988
MEDIUMWEIGHT PERCHERONS						
6	Taylor	500	1,446	125.00	5,167	2,382
7	Wightman	573	1,348	135.00*	4,977	2,373
8	Eldred	470	1,323	135.00*	4,966	2,209
9	Hajek	646	1,560	155.00*	6,224	2,757
10	Brenner	523	1,273	125.00	5,275	2,260
HEAVYWEIGHT BELGIANS						
11	Webster	536	1,640	167.50	5,641	2,620
12	Hunt	641	1,420	140.00	6,265	2,655
13	Becker	761	1,580	150.00	6,398	3,078
14	Arms	651	1,436	160.00	5,874	2,703
15	Clever	636	1,545	155.00	5,906	2,756
MEDIUMWEIGHT BELGIANS						
16	Frost, F	560	1,355	140.00	5,179	2,421
17	Frost, G	598	1,530	150.00	5,893	2,700
18	Hulett	640	1,473	155.00	5,860	2,648
19	Thorburn	633	1,405	142.50	5,454	2,544
20	Read	656	1,400	140.00	5,640	2,664
HAYSTACK GROUP						
21	King	670	1,363	120.00	13,800**	
22	M. S. C.	920	1,646	152.50	13,800**	
23	Box	633	1,416	155.00*	13,800**	
24	Rogers	676	1,610	160.00	13,800**	
25	Hart	696	1,486	90.00	13,800**	
26	Kiss	700	1,506	125.00*	13,800**	
MEDIUMWEIGHT STALL-FED						
27	Walker	525	1,266	127.50	12,928	5,003
HEAVYWEIGHT STALL-FED						
28	Darling	640	1,540	100.00*	15,040	5,933

*Appraised value based on price of individuals sold.
**Estimated consumption.

TABLE 2—*Average weight, feed and sale price*

	Average Weight		Gain	Average Feed Consumed		Average Selling Price
	Beginning	End		Hay	Grain	
	pounds	*pounds*	*pounds*	*pounds*	*pounds*	
Heavy Percherons	649	1,583	934	5,784.8	2,809.5	$136.00
Mediumweight Percherons	542	1,390	848	5,321.9	2,396.18	135.00
Heavy Belgians	645	1,524	879	6,016.8	2,762.26	154.50
Mediumweight Belgians	617	1,432	815	5,605.2	2,595.4	145.50
Haystack group	716	1,505	789	13,800.0	.....	133.75
Mediumweight stall-fed	525	1,266	741	12,928.0	5,003.0	127.50
Heavyweight stall-fed	640	1,540	800	15,040.0	5,933.0	100.00

so much during the growing period but came through with large frames and sound legs in surprisingly good condition for the little attention received.

Colts 27 and 28 were confined to box stalls after April of the first winter and fed weighed amounts of grain and hay similar to the winter rations of numbers 1 to 20. They consumed more feed and thus cost more to develop than did those in the other groups. While these colts gained well, the extra labor and cost involved are not justified where pasture is available. There are also greater possibilities of leg and body deformities if proper attention is not given to exercise and the trimming of the colts' feet when raised in dry hard stalls. While only two colts were grown in this manner, these deformities of body and limb were very evident.

The amount of feed consumed to Feb. 28, 1942, sale price on April 8, together with initial and final weights, are shown in Table 1.

The sale prices in Table 1 and average sale price in Table 2 show that slightly higher prices were paid for the heavier horses. It must be pointed out, however, that individuality, as well as weight, and preference for Belgian colors influenced prices as shown by the higher average price of Belgians over Percherons in Table 2. A comparison of the stack-fed colts with the 20 stall-fed colts shows a slight price advantage in favor of the stall-fed ones, which would not pay for the difference in feed and care.

The stack-fed colts are each charged with an estimated 13,800 pounds of hay for the three winters' total consumption. In order to obtain accurate data concerning amounts of hay consumed by colts wintered on hay with no grain, 20 draft and cross-bred colts were fed amounts of hay the following winter. Results were reported in the August 1943 Quarterly Bulletin and show that on the average, rising two-year-olds ate 2.68 tons of hay each. They ranged in weight from a yearling Arabian of 610 pounds to a Belgian gelding of 1,520 pounds.

Fig. 1. This colt was grown without grain until three years of age. His weight as a six-year-old is 2,285 pounds.

Eight of the colts, numbers 4, 5, 7, 8, 9, 23, 26 and 28, listed in Table 1 were kept to maturity to see what their final weight would be. Four of them, numbers 5, 7, 8, and 23, were mares of good type and were used as three-year-olds for the cross-breeding program.

Weights of the horses were (see Table 1):

Number	As Two-Year-Olds	As Five-Year-Olds
	pounds	*pounds*
4—Foster	1,668	1,800
5—Price	1,501	1,590
7—Wightman	1,348	1,475
8—Eldred	1,323	1,475
9—Hajek	1,560	1,800
21—King	1,363	1,570
22—M. S. C.	1,646	2,285
23—Box	1,416	1,640
25—Hart	1,486	1,700
26—Kiss	1,506	1,850
28—Darling	1,540	1,590

The weights show that horses grown on pasture with only hay stacks for shelter in the winter time (Numbers 21, 22, 23, 25 and 26) made as much final weight as horses fed grain and hay in single or box stalls during the winter.

Other studies along this line were carried on with draft, cross-bred and Arabian colts through the years 1940 to 1945 with the same results so that this plan for raising good sound colts of all types at low cost for feed, labor and housing has become standard practice at Michigan State College and made possible the sale of horses at more nearly a profit on the low prices for horses current at the close of the war.

Standard practice at Michigan State College is as follows:

One pound of whole oats per 100 pounds of live weight daily with pasture as foals.

One pound of whole corn and oats per 100 pounds of live weight daily with hay and pasture as weanlings.

Pasture during summer. Uncut meadow and stacked hay during the winter as yearlings.

Pasture during the summer. Uncut meadow and stacked hay during the winter as two-year-olds.

Pasture during the summer. Break as rising three-year-olds in the fall.

Hay, uncut meadows and pasture fields are seedings of alfalfa and brome with volunteer June grass and clover.

Housing consists of an open shed which is available for shelter but seldom used in winter, the horses seemingly content in protection afforded by the hay stacks.

The shed is used more during the summer when flies are bad.

The second phase of the study began in the spring of 1942 when four of the mares, numbers 5, 7, 8, and 23, were mated to an Arabian stallion. The mares, all grade Percherons, two blacks and two greys, were to be worked on the farm when needed and at all other times, both winter and summer, turned out on pasture with other horses. The general plan for mating called for two years' mating with an Arabian stallion, two years with a Thoroughbred, two years with a Morgan, then with draft stallions for two years each from the Percheron and Belgian breeds.

The fillies from the Arabian crosses will be mated with Arabian stallions, likewise the Thoroughbred and Morgan crosses with stallions

Weights in pounds of draft and cross-bred colts raised at Michigan State College

LOT 1 — Hay and pasture without grain until three years old				LOT 2 — Box stalls and grain and hay first winter as weanlings. Hay and pasture thereafter			
	Nov. 15, 1943	Nov. 15, 1944	Nov. 15, 1945		Nov. 15, 1943	Nov. 15, 1944	Nov. 15, 1945
Suffolk-Arab. filly	480	.....	Died ("flu")	Price Perch.-Arab. filly	530	975	1,170
Suffolk-Arab. gelding	560	860	1,135	Eldred Perch.-Arab. filly	420	800	1,110
Suffolk-Arab. filly	660	1,100	1,235	Reno-Perch. filly	910	1,475	1,790
Cleveland Bay-Arab	600	880	Died ("flu")	Tonette-Perch. filly	770	1,225	1,525
Tenn. Walking-Arab	370	660	905	Tenny-Perch. filly	880	1,340	Sold as a 2-year-old
Perch.-Arab. gelding	450	795	1,040	Coreenet-Perch. filly	650	1,235	Sold as a 2-year-old
Corolate-Perch. gelding	650	1,170	1,600	R. de Wolfe-Belg. filly	700	1,190	Sold as a 2-year-old
Coletor-Perch. gelding	850	1,250	1,580	M. Success-Belg. filly	800	1,390	Sold as a 2-year-old
M. Coreenet-Perch. gelding	800	1,215	1,480	Hullet-Belg. filly	700	1,260	Sold as a 2-year-old
V. de Wolfe-Belg. gelding	800	1,165	1,470	Coro-Perch. gelding	730	1,215	1,550

First weights November 15, 1943, were taken shortly after colts were weaned.

of those breeds, and returned again to draft stallions for the third cross in each case.

All colts will be fed grain supplemented with hay and pasture their first winter as weanlings and no grain thereafter either winter or summer until they are brought in for training both under saddle and in harness for work or driving.

The progeny record with weights of colts to date is shown in the following tables:

Grey Mare—Eldred No. 8

Foaled in 1939. Fed grain to maturity. Weight 1,500 pounds.
Sire: Buster 194944, grey Percheron stallion weighing 1,700 pounds.
Dam: Grade Clydesdale mare. Bay, weighing 1,450 pounds.

Bred	Stallion	Progeny	Weight in pounds		
			At birth	1 Year	2 Years
1942	Arabian, Amidore	Filly, bay	.....	600	980
1943	Arabian, Amidore	Filly, bay	.....	750	.....
1944	Thoroughbred, Stormscud	Filly, black	127	.....	.....

Fig. 2. Eldred No. 8 with 1943 foal from Arabian stallion Amidore.

Grey Mare—Wightman No. 7

Foaled in 1939. Fed grain to maturity. Weight 1,500 pounds.
Sire: Buster 194944, grey Percheron stallion weighing 1,700 pounds.
Dam: Grade Belgian mare. Chestnut. Weighing 1,300 pounds.

Bred	Stallion	Progeny	Weight in pounds		
			At birth	1 Year	2 Years
1942.	Arabian, Amidore	Colt, grey		470	905
1943.	Arabian, Amidore	Filly, grey		820	
1944.	Thoroughbred, Stormscud	Colt, grey	126		

Black Mare—Box No. 23

Foaled in 1939. Fed no grain to maturity. Weight 1,850 pounds.
Sire: Mediator (Major H) 209523, black Percheron stallion weighing 1,950 pounds.
Dam: Grade Percheron mare. Black. Weighing 1,650 pounds.

Bred	Stallion	Progeny	Weight in pounds		
			At birth	1 Year	2 Years
1942.	Arabian, Amidore	Colt, brown	Colt died (not owned by mother)		
1943.	Arabian, Amidore	Colt, brown			
1944.	Thoroughbred, Stormscud	Filly, black	150	810	

Black Mare—Price No. 5

Foaled in 1939. Fed grain to maturity. Weight 1,800 pounds.
Sire: Mediator (Major H) 209523, black Percheron stallion weighing 1,950 pounds.
Dam: Grade Belgian mare. Bay. Weighing 1,650 pounds.

Bred	Stallion	Progeny	Weight in pounds		
			At birth	1 Year	2 Years
1942.	Arabian, Amidore	Filly, bay		710	1,080
1943.	Arabian, Amidore	Colt, brown		850	
1944.	Thoroughbred, Stormscud	Colt, black	152		

Feeding schedule. Grain consisting of corn and oats, equal parts by weight, first winter as weanlings. Pasture and hay thereafter until brought in for training for work in harness and under saddle.

CONCLUSIONS

1. Based on the first phase of study, it can be stated that colts can be raised to maturity more profitably out-of-doors on pasture during the summer and from uncut meadows and stacked hay during the winter.

2. Colts can be so raised without sacrifice in final weights.

3. As compared with colts housed in single and box stalls, colts so grown had better legs and feet.

4. Colts receiving grain the first winter as weanlings had greater resistance to distemper than those wintered on hay and pasture.

5. Colts developed on roughage were not in ready condition for sale as yearlings or two-year-olds, but at present low prices for draft horses the cost of producing them is more likely to be under the selling price.

6. The four fillies which were kept for breeding have worked in harness when needed but the rest of the time they have lived an outdoor life with plenty of good hay and pasture always available both winter and summer. In the three years since they were first bred as three-year-olds they have produced 12 colts, showing that this sort of treatment is ideal for raising and maintaining brood mares.

USE OF 2, 4-DICHLOROPHENOXYACETIC ACID FOR THE IMPROVEMENT OF GREENHOUSE TOMATO PRODUCTION

By M. C. STRONG
SECTION OF BOTANY AND PLANT PATHOLOGY

AFTER HOWLETT (2) AND Strong (4) demonstrated that greenhouse tomato production could be improved by the application of growth promoting chemicals, considerable interest was aroused in this problem. Several new growth-regulating chemicals have been discovered (6), and new methods for their application have been described (1).

One of the chemicals reported by Zimmerman (6) to be very effective for inducing parthenocarpy in tomatoes is 2, 4-dichlorophenoxyacetic acid. This compound has lately received much publicity as a weed killer when applied in a far greater concentration than is used for inducing parthenocarpy, and is commonly referred to as "2, 4-D". Tests to determine the effectiveness of this hormone in the improvement of greenhouse tomato production are here reported.

METHODS

Two crops of John Baer tomato plants were grown in a house of 4,000 cubic feet capacity in a sandy loam soil previously steam sterilized. A 4-12-8 commercial fertilizer was applied at the rate of 10 pounds per 1,000 square feet when the plants were set and a side-dressing of ammonium sulfate was used as necessary. Moisture was supplied by ground irrigation. Eighty plants were set 12 inches apart each way with a 2-foot aisle between every two rows. Plants were pruned to a single stem and supported on 1 inch vertical wooden stakes.

2, 4-dichlorophenoxyacetic acid was used as a spray in water at the rate of 10 parts per million, the optimum concentration recommended by Zimmerman (6). The acid was first dissolved in a small quantity of ethyl alcohol and then added to the water. The resulting spray was applied with an ordinary DeVilbiss atomizer to the flowers only, considerable care being exercised not to wet the foliage. The flower clusters were usually sprayed once when three blossoms were open and two or three buds were well developed. Some clusters received

ARTICLE 28-29

two spray applications at a 5-day interval. Several unsprayed flowers were always pollinated for comparison with those sprayed.

This growth regulator was also applied in the form of a vapor. Methyl dichlorophenoxy acetate (1 mg. per 500 cubic feet) was vaporized on an electric hot plate with an electric fan operating nearby as described in a previous report (5). The greenhouse was left closed for 15 hours. All the plants in the house were exposed to the vapor, and there were no untreated fruits for comparison. A smaller vapor concentration (1 mg. per 800 cubic feet) of methyl dichlorophenoxy acetate was also tested.

RESULTS FROM SPRAYING FLOWER CLUSTERS WITH 2, 4-D

The results of the various methods of treatment tested are summarized in Table 1. On the first cluster of the spring crop (February

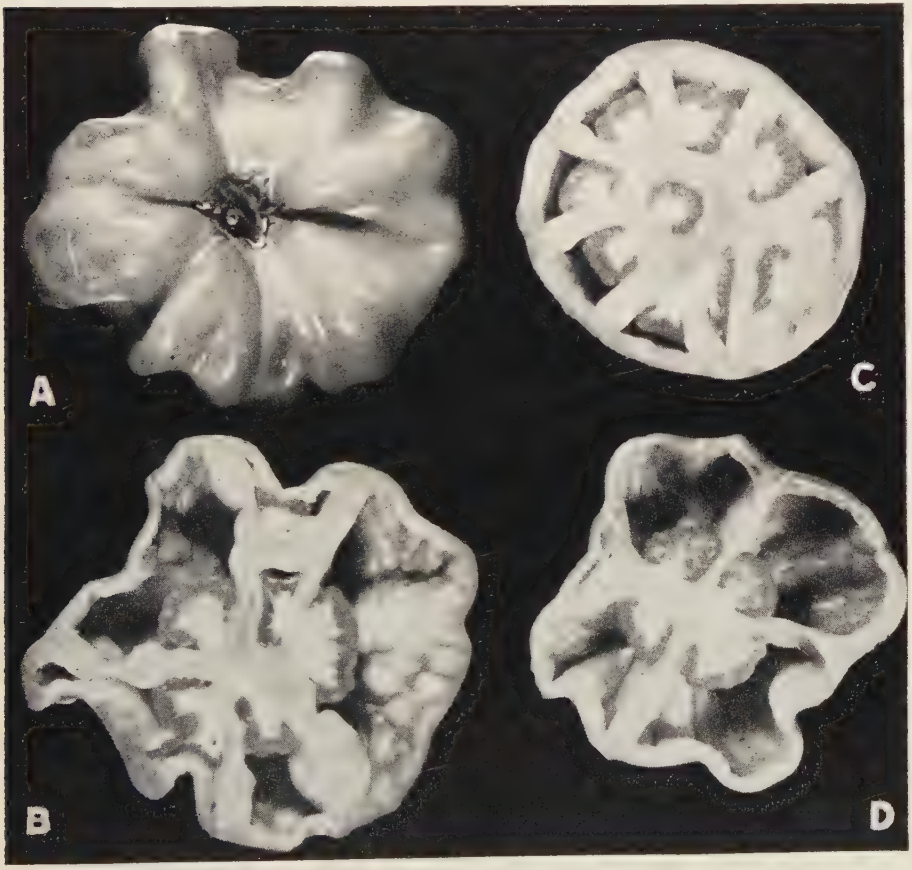

Fig. 1. Parthenocarpic tomato fruits induced by 2,4-D spray (10 p.p.m.) A and B showing exterior and interior views of hollow fruit, C and D, various stages of "puffiness," C, salable, D, unsalable.

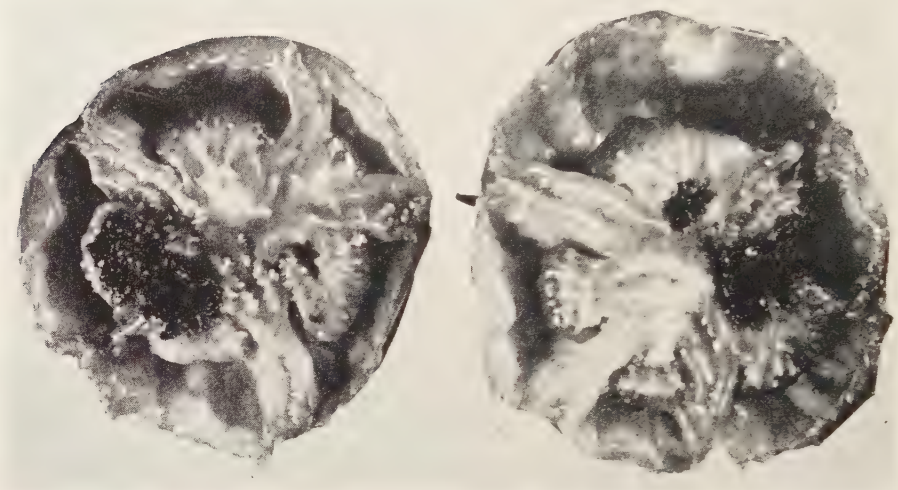

Fig. 2. Cross section of parthenocarpic tomato showing a black internal breakdown.

TABLE 1—*The effects of 2,4-dichlorophenoxyacetic acid on the production of greenhouse tomato fruits*

Treatment	Date	Number flowers treated	Number fruits set	Percentage set	Average weight fruit	Average time to maturity	Percentage salable
				percent	*ounces*	*days*	*percent*
Pollinated	2–26	15	12	80	4.5	68	91
2, 4-D spray, once	2–26	39	34	87	7.2	53	59
Pollinated	3–1	13	12	92	5.7	65	100
2, 4-D spray, once	3–1	48	40	83	6.3	58	71
Pollinated	3–5	33	28	84	4.8	65	87
2, 4-D spray, once	3–5	39	32	82	5.2	58	80
2, 4-D vapor, 1 mg. per 500 cu. ft.	3–19	446	410	92	5.7	55	93
2, 4-D vapor, 1 mg. per 800 cu. ft.	4–18	246	59	24	3.8	55	84
Pollinated	4–24	13	13	100	5.3	62	92
2, 4-D spray, once	4–24	149	122	82	5.0	52	90
Pollinated	5–29	10 open	10	100	—	—	—
2, 4-D spray, once	5–29	50 open	36	72	—	—	—
	5–29	50 old	23	46	—	—	—
Pollinated	10–24	25	10	40	3.7	62	100
2, 4-D spray, once	10–24	49	40	82	5.0	55	91
Pollinated	10–29	70	27	38	3.2	59	100
2, 4-D spray, once	to	141	118	84	4.9	58	83
2, 4-D spray, twice	11–20	165	93	56	4.4	59	57

26 to March 5 inc.), the percentage of fruit set by one 2,4-D spray treatment averaged approximately the same as that by pollination. The average weight of fruits resulting from the spray was 6.2 ounces as compared with an average of 4.9 ounces for pollinated fruits. The average period from blossoming to fruit ripening was decreased 9 days by one 2,4-D spray application. However, the percentage of unsalable fruits was greater among those induced by the hormone spray than among fruits resulting from pollination. Some of the parthenocarpic tomatoes were entirely hollow and resembled large red peppers (Fig. 1), while others showed a black breakdown of the internal tissue which was not visible from an external examination of the fruit (Fig. 2). Many of the parthenocarpic fruits were pointed at the blossom end (Fig. 3). This condition was not considered to affect salability if the fruit was well filled out.

In the fall crop the percentage of set, as well as size of fruit, was considerably increased by one application of 2,4-D spray. The set from pollinated flowers was low, as is usual in that season, and the fruit was small. One treatment doubled the set over that from pollination and increased fruit size approximately 20 percent.

Two applications of 2,4-D spray to the same cluster failed to increase either percentage of set or weight of fruit over that resulting from one application. In fact, the second application of this spray seemed to slow down the development of some ovaries that had already begun to swell, produced a definite lesion on the peduncle (Fig. 6), and decreased the percentage of salable fruits from 83 to 57 percent owing

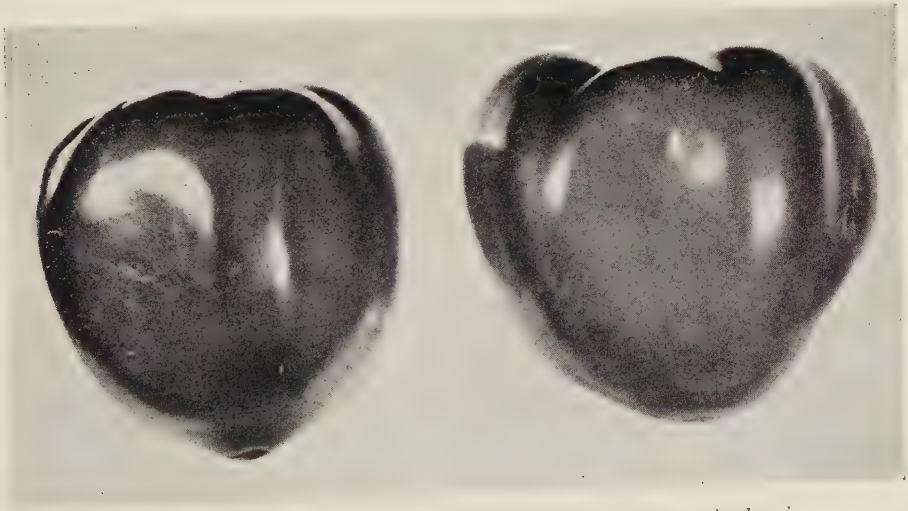

Fig. 3. Tomato fruit induced by 2,4-D spray (10 p.p.m.) showing characteristic pointed blossom end.

Fig. 4. Tomato plants in greenhouse showing: A, untreated control plant with normal foliage; B, several plants with elongated internodes and distorted foliage above, normal foliage below. This effect was produced by two 2,4-D spray (10 p.p.m.) applications each on the three lower flower clusters.

to small size as well as the hollow condition and black internal breakdown previously mentioned (Figs. 1 and 2).

Moreover there seemed to be a cumulative effect of the spray. Plants having several clusters that were sprayed twice began to show the typical elongation of the internodes and leaf distortion associated with applications of this chemical (Figs. 4 and 5). Untreated control plants exhibited normal foliage. The foliar distortion ranged all the way from slight to severe, depending on the number of applications of 2,4-D received. This behavior of the treated plants suggests that 2,4-D was absorbed through the flowers and presumably transported to all parts of the plant in sufficient quantities to produce these effects. All young foliage exhibited the distortion whether at the top of the plant or on suckers at the base of the stem. Affected plants began to produce normal leaves again in about one month after spray treatments of the flower clusters were discontinued. Several clusters of

Fig. 5. Close-up of tops of tomato plants in Fig. 4. A, untreated control plant with normal foliage; B, elongated internodes and distorted foliage produced by 2,4-D spray applications on flower clusters.

flowers on affected plants were pollinated, and the resulting fruits were observed to have the pointed blossom end characteristic of parthenocarpic fruit induced by this hormone (Fig. 7). These pollinated untreated fruits were also seedless.

Spray treatments with 2, 4-D were most effective on open flowers, only about 50 percent effective on buds and failed entirely to set fruit on old flowers. However, it was found (May 29 treatment) that the spray was more effective on old dry flowers (2 weeks past bloom) if the dry corollas were removed and the spray applied directly on the ovaries. A 46-percent set of fruit was obtained by such treatment as compared with 72-percent set from spraying open flowers and a 100-percent set from pollination. Since all the plants were pulled in June none of these fruits reached maturity but were showing good development at that time.

RESULTS FROM VAPOR TREATMENTS WITH 2, 4-D

The higher concentration of vapor tested (1 mg. per 500 cubic feet) induced a 92-percent set of fruits of good size (5.7 ounces average weight) and good quality (93-percent salable) in an average period of 55 days from blossoming to fruit ripening. However all plants soon

exhibited marked deformation of the young foliage and an inhibition of the development of new blossom buds. A month elapsed before the next cluster bloomed.

The lower concentration of vapor tested (1 mg. per 800 cubic feet) did not produce any deforming effects on the foliage nor did it inhibit

Fig. 6. Tomato clusters showing various deleterious effects of 2,4-D. (10 p.p.m.). A, three younger flowers failed to develop. Three older flowers produced small fruits. Note swelling and splitting of the peduncle; B, three flowers failed to develop. One flower produced a very small fruit. The peduncle is twisted and shows white swollen areas; C, three ovaries began to swell but soon stopped. The peduncle is elongated, twisted and shows white swollen areas.

Fig. 7. Two clusters on a tomato plant which had received two 2,4-D sprays each on the three lower clusters. The lower cluster illustrated, which is the third one on the plant, failed to develop. The upper cluster shown here was pollinated and unsprayed but the resulting fruit exhibited the pointed blossom end characteristic of treated fruit and were seedless. Note also the distortion of the foliage.

subsequent blossoming. However only 25 percent of the flowers so treated set fruit. The fruits were small (3.8 ounces average weight) and about 16 percent were unsalable for this reason.

DISCUSSION AND SUMMARY

It has been shown by the tests here reported that one application per cluster of 2, 4-dichlorophenoxyacetic acid used as a spray (10 p.p.m.) considerably increased the size of tomato fruits over those produced by hand pollination, and decreased the period from blossoming to fruit ripening by one to two weeks. A greater increase in number of fruit set by this spray as compared with pollination was obtained in a fall crop than in a spring crop. These findings are in general agreement with the results of Murneek, Wittwer and Hemphill (3).

The fruits induced by the February and March spray applications may also have been favorably affected by the subsequent vapor treatment of March 19. However the control fruits resulting from pollination were subjected to the same vapor treatment and any beneficial or harmful effects were shared equally by both sprayed and pollinated fruits. The resulting comparisons are therefore fair. There was some reduction in number of seeds in these pollinated control fruits but none were seedless.

The reduction in leaf area resulting from foliar deformation might be expected to decrease the size of fruits. However, this effect may have been balanced by the lack of competition for food by the third cluster which was delayed in development one month by the vapor treatment. The distorted foliage failed to furnish sufficient shade to prevent sunscald of the exposed fruit, necessitating bagging of the fruit.

A second application of 2, 4-D spray to the same cluster failed to increase either set or size of fruit over that induced by pollination and was detrimental to the development of some ovaries. There seemed to be a cumulative effect from five or more spray applications on the same plant which resulted in the typical lengthening of the internodes and deformation of foliage. Murneek, Wittwer and Hemphill (3) mention no such deleterious effects from two spray applications per cluster on Marglobe. Their tests were all conducted on spring crops, while the test reported here was made on a fall crop. It is possible that the higher temperatures and greater necessary ventilation in the warmer season facilitate the elimination of the hormone from the plant or that more rapid plant growth exhausts the chemical at a faster rate so that it does not accumulate.

The vapor concentration (1 mg. per 500 cubic feet) recommended by Zimmerman (6) induced a 92-percent set of fruits having an aver-

age weight of 5.7 ounces. However this vapor concentration produced severe foliar deformation and inhibited flower bud development for approximately 4 weeks. A smaller concentration (1 mg. per 800 cubic feet) produced no foliar distortion but was insufficient to yield more than a 25-percent set of small fruit. Whether an intermediate concentration between these two limits would strike a satisfactory balance between beneficial and harmful effects was not determined.

2, 4-dichlorophenoxyacetic acid is an exceedingly potent hormone for the production of parthenocarpic tomato fruit but it has very undesirable deforming effects on foliage which makes it hazardous to apply either as a vapor treatment or as a spray on blossom clusters.

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DUST FUNGICIDES VERSUS FORMALDEHYDE IN THE CONTROL OF ONION SMUT

By RAY NELSON
SECTION OF BOTANY AND PLANT PATHOLOGY

ONION SMUT first was reported in America by Ware in 1869 (6)[1] as already the cause of serious concern among onion growers in the Connecticut River Valley. It has since been widely disseminated on dry sets and has become established in most of the major onion-growing sections where climatic conditions are favorable for its development. The disease does not occur in the southern onion districts where the seed for the winter crop is sown in the late summer or early fall. This regional limitation is due to the effect of soil temperature on infection of the onion seedling during a comparatively brief period of susceptibility. This temperature effect is apparently responsible for the European limitation of the disease to the cooler northern countries.

Smut is a disease of seedling onions only and the period of susceptibility is limited to three or four weeks following seed germination. The pathogen (*Urocystis cepulae*) is a soil-invading fungus which infects the seedling only through the tender parts of the cotyledonary tissues. The young plant attains immunity to infection with the appearance of the first leaf. Plants grown from dry sets are immune as are seedlings grown in smut-free soil and transplanted into infested soil.

The onion seedling may be invaded at any point between the root joint and the knee of the cotyledon. A few days after infection occurs visible smut lesions are present and can be detected by observing the seedling in transmitted light. The developing lesions are visible as darker green areas in the leaf or cotyledonary tissues. Later the fruiting pustules of the fungus are matured just below the epidermis which is finally ruptured by powdery, black masses of spores. The exposed spores drop to the soil, or they are washed off by water and carried on tools, shoes, by wash water or other ways to other sections of the field. They may be widely disseminated on sets or transplants to other localities and, once introduced into onion fields where soil conditions are favorable for its development, the fungus increases until the soil is

[1]The numbers in parentheses refer to "Literature Cited," p. 247.

ARTICLE 28-30

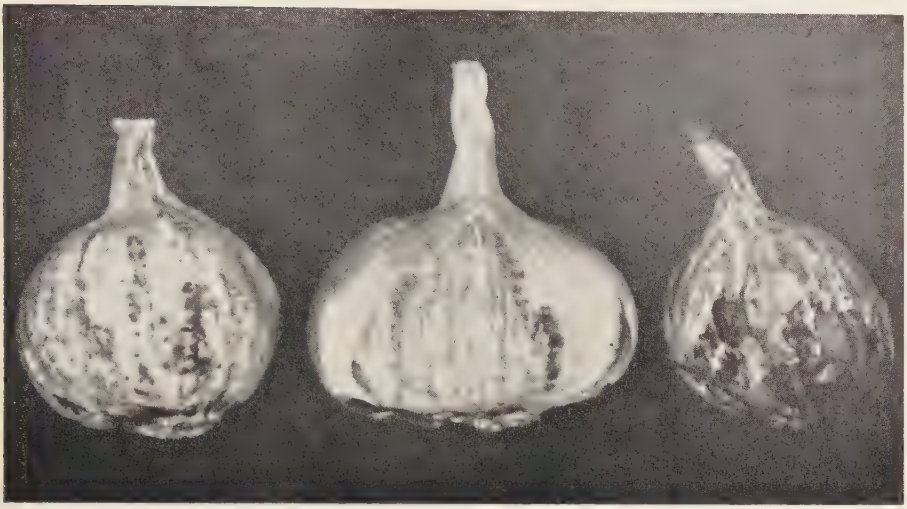

Fig. 1. Smut lesions under scales of mature bulbs of Yellow Globe onion.

so densely infested that profitable onion culture is no longer possible without application of effective control measures.

A majority of the infected seedlings die within a short time after they appear, resulting in a thinning of the stand early in the season, (Fig. 2B-X). Some of the diseased plants live until midseason or even harvest, the new leaves becoming infected as they develop and occasionally smutted bulbs large enough for market are matured. These show powdery black masses of spores beneath the scales (Fig. 1). Such diseased bulbs are especially subject to attack by fungi that cause storage decays, and if they are not rapidly and thoroughly cured they are usually destroyed during the curing or storage periods. Some diseased seedlings are easily identified in the row by the abnormally thickened, curled leaves (Fig. 2B-Y), and successive infected leaves that are produced may display these symptoms as long as the plant remains alive.

Onion smut thrives in the northern onion districts because the fungus is sensitive to soil temperatures. The most favorable soil temperatures for infection of the onion seedlings are from 55° to 72° F., a range which is characteristic of the temperatures of Michigan onion soils in a normal spring season. Abnormally cool spring weather, which delays emergence and development of the young onion plant, prolongs the period of susceptibility and usually results in greatly increased amounts of smut. Conversely, weather favorable for rapid growth following germination curtails the susceptible period and less smut develops. Since only the seedling leaf (cotyledon) is susceptible, if it escapes infection until mature (normally about 3 weeks from germination), no

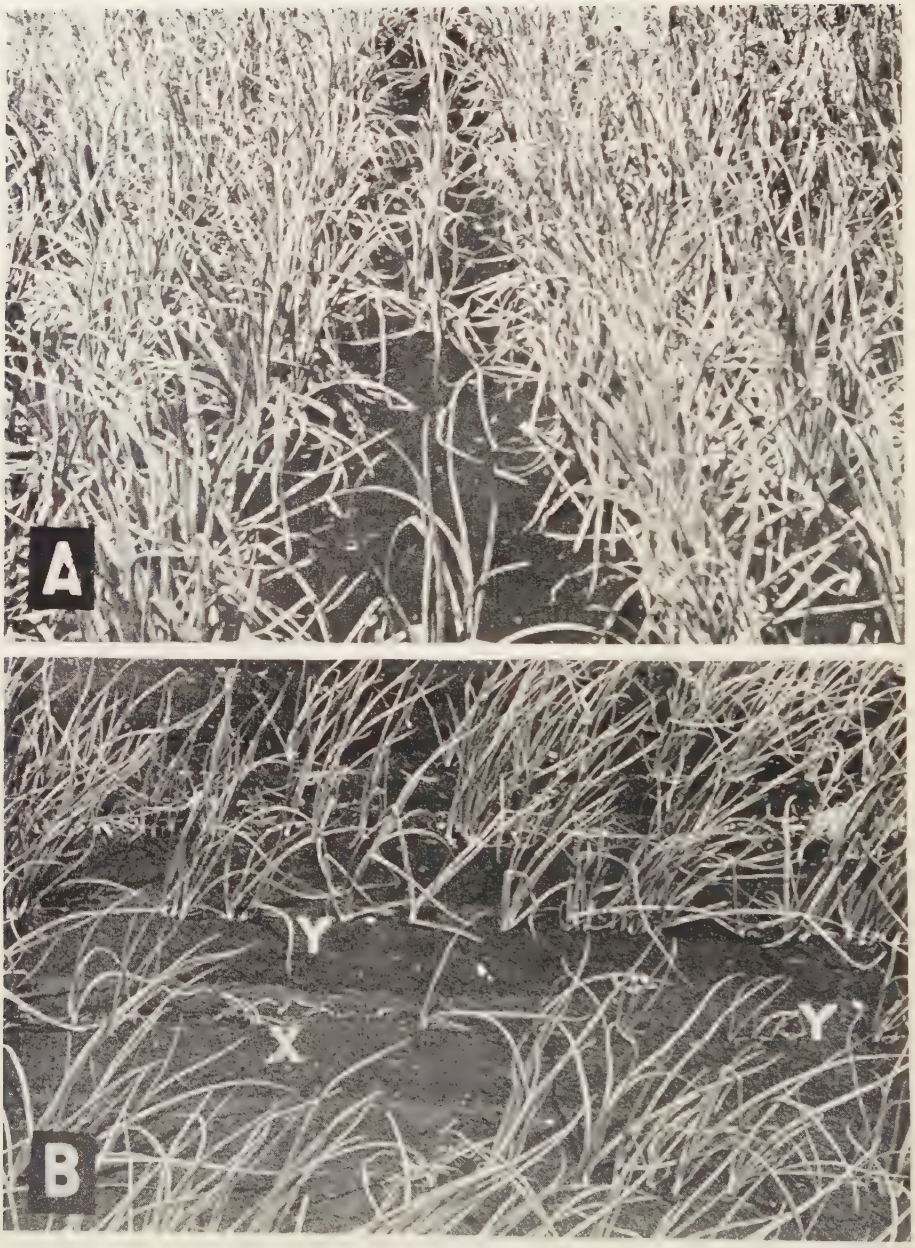

Fig. 2. Thin stand as a result of smut development in one row of Yellow Globe onion unprotected by formaldehyde. One formaldehyde discharge tube on the seeder became plugged and no fungicide was applied to the soil.

Fig. 2B. X—Young onion plants killed by smut; Y—Dwarfing of young plants and distortion of leaves as a result of smut infection.

further invasion can occur even in soils very heavily infested with the smut fungus. If the mean soil temperature is 84° F. or higher no infection occurs because the fungus is inactivated at these temperature levels. Seedlings tend to outgrow the disease at temperatures slightly below 84° F. In Michigan, soil temperatures are very favorable for infection during the period of seedling susceptibility but in the South, where the seed is sown in late summer, soil temperatures are high enough to inactivate the smut fungus.

Onion smut occurs in most of the main onion districts of Michigan and medium to heavy soil infestation is characteristic of many of the fields in the areas of most intensive culture. The range of the disease is constantly increasing and each year additional growers must use preventive measures to obtain profitable crops. Where protective treatments are not used losses in the crops grown from seed may run as high as 50 percent in seasons favorable for infection.

In the intensive culture of onions, as practiced in most of the major onion districts, only one effective method of smut control has been devised. This consists in applying a dilute solution of formaldehyde to the soil in the drill row with the seed. Selby in Ohio (4) in 1900 first demonstrated the efficacy of this treatment and, although various modifications have since been recommended, they have consisted mainly of stronger solutions and in improved methods of application.

Various dilutions of formaldehyde have been recommended, ranging from 1 pint in 8 gallons to 1 in 16 gallons. Where the more dilute solution is used the recommended rate of application is 16 gallons per 3,000 feet of row or approximately 200 gallons per acre. With stronger solutions a corresponding reduction in the rate of row application is necessary. When the soil is already wet, as it commonly is in Michigan at the time of seeding in April, the addition of the larger volumes of solution to the row makes the muck sticky and it adheres to the seed spouts, leveling shoes or packer wheels on the seeder and increases operational difficulties. Because of this, a much stronger solution is commonly used in Michigan, one pint of formaldehyde to 8-10 gallons of water with row applications of 80 to 115 gallons per acre.

There are increased hazards associated with the use of the stronger solutions. If the soil is dry they may cause excessive injury to the seed with a corresponding reduction in stand. On the other hand, if heavy rains immediately follow the application of the weaker solution the dilution of the fungicide impairs its effectiveness and smut may not be well controlled. Thus the moisture content of the soil and the weather immediately following seeding are important factors in the safety and effectiveness of the standard method of smut control. The stronger solution is needed in wet soils and the weaker one in dry

fields. It is thus advisable to alter the strength of the solution to correspond to the moisture content of the soil on the day of seeding. It has been shown by Anderson (1) that formaldehyde injury to the seed occurs immediately after seeding and is not affected by weather conditions during subsequent days. It is generally agreed also that the effectiveness of formaldehyde treatments is altered by weather conditions only during the 24 hours subsequent to seeding. If no rain follows within 24 hours the vapor of the fungicide permeates the soil above the seed and renders the smut fungus harmless.

Although formaldehyde has given very effective control of onion smut, practical onion farmers have long voiced serious objections to its use, especially on muck soils. There is much extra labor involved in hauling large volumes of water to the fields and in the frequent refilling of the small tanks that are attached to the seed drills. The weight of the drill is greatly increased by the formaldehyde solution and in wet muck this often seriously interferes with the mobility of the motorized equipment. These objections are in addition to those arising from the messy operations associated with the sticky muck adhering to the seed spouts, levelers or packing wheels of the drills. Such objections have long made it desirable to develop simpler and less laborious methods of control. The breeding of resistant varieties of onion has seemed the most desirable solution and work on this problem has been in progress in Michigan for several years.

During the war the development of new fungicides led to experiments in the control of onion smut with some of the most promising dust materials mixed with the seed at the time of drilling or stuck to the seed with special binding materials. Experiments were begun in Michigan in 1943 with such dusts, in cooperation with pathologists in a number of other states who were making similar tests. These experiments have aroused much interest among Michigan onion farmers who use formaldehyde. Reports in 1944 of the results from some other states stimulated additional interest in these methods, and some Michigan onion growers made test plantings in 1945 on their farms. Their comments and the resulting publicity make it desirable to present now the results of controlled experiments in testing the comparative value of the dust treatments and formaldehyde so that all growers may use these data as a guide in making decisions as to what treatment to use in the 1946 crop for the prevention of onion smut.

Some disadvantages of the formaldehyde method have been described. The advantages of a simple, effective dust treatment would be numerous and include the following: (1) reduction in weight of the drill which would permit earlier planting in wet seasons when the additional weight of the formaldehyde often bogs down the drill; (2)

eliminate much of the trouble from wet, sticky muck adhering to drill parts; (3) reduced drill weight would make possible shallower seedings with a resultant quicker emergence of seedlings and consequently would shorten the period of maximum susceptibility to smut infection; (4) eliminate the risk of reduction in the effectiveness of the treatment by dilution since rain following soon after seeding weakens the fungicidal power of the formaldehyde; (5) make easier a more uniform rate of seeding since the dust-treated seed can be run through the drill more evenly and spaced better in the row; (6) most important, it would result in great labor savings and consequently shorten the seeding time which is a critical factor in seasons when planting conditions are frequently unfavorable and very changeable. The earlier seedings often are the most productive if smut is well controlled. Seeding operations are frequently interrupted for days by unfavorable weather when the formaldehyde method cannot be used. Any dust treatment that will shorten the seeding period would bring major benefits to Michigan onion growers.

MATERIALS AND METHODS

The smut control experiments were conducted on commercial onion farms in the Gun Swamp area on muck soil in which onions have been grown continuously for many years. This is one of the older onion sections, and onion smut first became commercially important in Michigan in this area. The formaldehyde method of smut control is generally used, and failure to practice this treatment results in very serious reductions in yields. In the fields used for these experiments the soils are as heavily infested with the smut fungus as any in Michigan.

The experiments were conducted in 1943, 1944 and 1945 but complete data were not obtained in 1944, and complete records only from the 1943 and 1945 tests are included here.

The major objective of the tests was to determine whether dust fungicides applied to the seed would control smut as well as liquid formaldehyde applied in the drill row with the seed. Preliminary work in New York state indicated that dusts containing tetramethyl thiuramdisulphide and ferric dimethyl dithiocarbamate (Arasan and Fermate) as the active ingredients might provide satisfactory protection to onion seedlings against smut infection. Two forms of the first dust were used, each containing 50-percent tetramethyl thiuramdisulphide and differing only in the conditioning agent while Fermate contained 70-percent active toxicant.

In the 1943 tests the seed was treated by Dr. A. G. Newhall at Cornell University and sent to various cooperators for planting in smut-

infested soil. He also included Catex, a by-product of turpentine distillation, to be tested as a liquid substitute for formaldehyde since there seemed to be a shortage of formaldehyde. Seed of Early Yellow Globe onion was used in 1943 and Downing Yellow Globe in 1944 and 1945. In 1944 and 1945 the seed was treated at East Lansing. Since the preliminary tests had shown that relatively large quantities of dust must be used to control smut it was first necessary to treat the seed with a sticker to make it take up and hold the dust in sufficient quantities to control smut. In the 1943 tests a rosin-potash sticker was used, but a much superior one was developed for use in 1944 and 1945 (3). This consisted of a 5-percent solution of methyl cellulose (Methocel) applied to the seed at the rate of 4-6 ounces to each pound of seed. With this sticker one pound of seed would take up and hold one pound of the dust. The seed was first mixed with the sticker and spread out to dry for a short time and then shaken in a jar with the dust. The mixtures used are indicated in the tables

The plantings were made as early as the soil could be prepared and were concurrent with commercial seedings in the same fields. Randomized block planting designs were used and usually stand and smut records were taken at the appropriate times and yield records at harvest. In the 1943 and 1944 trials accurately counted numbers of seeds were planted in each plot but in the 1945 tests all the seedings were made with the tractor-drawn drills used by growers for their plantings.

RESULTS

1943 Experiments

These tests were conducted on the Kelly farm near Orangeville and included seven treatments and check with rows 8 feet long and 14 inches apart to conform to commercial spacing in the same field. A buffer strip of 12 inches was left between each block of treatments. The seed was sown by hand at the standard depth of drill seeding. Stand and disease records were taken two months after seeding since abnormally cool weather delayed development of the plants and smut. Seeding was done May 7 and the data in Table 1 are those from the July 1 records. The various treatments are also indicated in the table.

On May 7 when the plots were seeded the soil was dry but rain fell May 8 and at frequent intervals thereafter. The total precipitation for the month exceeded 10 inches or more than 2½ times the normal amounts. A portion of the experimental plots was inundated several times following very heavy showers, and smut developed more extensively in those sections directly in the path of surface runoff water. Thus the data from some treatments in blocks 4 and 5 are in-

TABLE 1—*Stand and disease records in onion smut control plots, Orangeville, Michigan, season 1943. 200 seeds sown in each plot row. Seeded May 7, stand and smut records July 1.*

Treatment	Block 1	Block 2	Block 3	Block 4	Block 5	Totals	Mean of Stands	Mean of Smut
							percent	*percent*
Arasan dust 1 lb. on 1 lb. of seed	X*84 Y 3	113 3	121 2	108 4	92 5	518 17	51.8	..... 3.28
Arasan dust ¾ lb. on 1 lb. of seed	124 3	122 3	115 6	89 2	142 4	592 18	59.2	..... 3.04
Fermate 1 lb. on 1 lb. of seed	116 4	89 2	98 6	95 3	116 4	514 19	51.4	..... 3.69
Fermate ¾ lb. on 1 lb. of seed	110 14	133 12	113 7	109 21	132 15	597 69	59.7	..... 11.55
Formaldehyde-drip 1-100, 15 cc. per foot of row	107 3	98 4	98 3	94 26	68 19	465 55	46.5	..... 11.83
Catex, 2-100 15 cc. per ft. of row	98 4	94 5	114 10	51 9	109 11	466 39	46.6	..... 8.37
Catex, 2½-100 15 cc. per ft. of row	97 7	98 5	111 16	99 16	109 11	514 55	51.4	..... 10.70
No treatment	80 17	108 24	104 33	86 29	95 36	473 139	47.3	..... 29.38

*X = number plants in row.
Y = number smutted seedlings

consistent with those from blocks 1, 2 and 3. The inclusion of the data from those plots makes statistical analysis difficult of interpretation and of doubtful value. There is no reasonable homogeneity among the variances of the various treatments and virtually all of the data responsible for this were contributed by blocks 4 and 5 that were excessively wet. Various transformations of the data were tested, but none resulted in any appreciable improvement in variance homogeneity. Results of the statistical analysis of these data are therefore omitted.

It can be seen however, that all of the treatments were better than no treatment and that the dusts were apparently superior to formaldehyde. If the data from the wetter plots are omitted then there are only slight differences among the dusts at the heavier dosage rate and formaldehyde. In all plots, however, reducing the dosage of Fermate from 1 pound to ¾ pound resulted in marked loss of effectiveness. It

is worthy of note, however, that the densest stands of seedlings developed in those plots which would indicate that the heavier dosages of the dusts were toxic to the seed.

The stand data were less variable than those on percentages of smut, but in general the denser stands were coupled with those treatments that were most effective in controlling disease. As mentioned, an exception was the Fermate treatment at the reduced dosage. The thinner stands in the plots treated with Arasan and Fermate 1 pound on 1 pound of seed and the very significant increase in the numbers of seedlings at the lesser dosage indicate that the heavier rate was injurious.

Yield records were taken at harvest time. Since an equal number of seeds was sown in each plot the mean yields are an index of the effectiveness of the treatments in the prevention of injury from smut and from damping-off. The mean yields of the 5 plots in each treatment were:

Arasan dust, 1 pound on 1 pound of seed	2.57 kilograms
Arasan dust, ¾ pound on 1 pound of seed	3.06 kilograms
Fermate dust, 1 pound on 1 pound of seed	3.00 kilograms
Fermate dust, ¾ pound on 1 pound of seed	3.03 kilograms
Formaldehyde 1-80	2.36 kilograms
Catex, 2-100	2.22 kilograms
Catex, 2½-100	2.38 kilograms
No treatment	1.73 kilograms

Yields were increased significantly by all the treatments, compared with those from the untreated rows. Arasan at the 1-1 rate did not increase yields more than did formaldehyde but at the 3/4-1 rate they were significantly higher. The Fermate treatments produced yields higher than those from formaldehyde and greater than those from Arasan at the 1-1 dosage. The influence of the Catex treatments upon yields was approximately the same as that of formaldehyde.

1944 Experiments

The 1944 experiments were restricted to comparisons of Arasan dusts at the 1 to 1 and 1 to 4 dosages. The dusts were stuck to the seed with the Methocel binder. Formaldehyde was used at a dilution of 1-80 and applied at the rate of 117 gallons per acre. A 4-block randomized layout was planted with 200 seeds in each treatment row. In addition, the 1-4 treatment was used for planting preliminary test plots to determine the effect of Arasan on the control of smut in seedings for set production. In such seedings the quantities of seed sown are at least 10 times those planted for bulb production.

The data from these plots were collected by the grower on whose farm the tests were conducted and who assisted in 1943 with all operations of seeding and record taking. He also took the yield records at harvest. Unfortunately the stand and smut records were lost before they were available to the writer who was unable to participate in recording the field data. Only the yield records were saved, but some information was obtained in consultation with the grower concerning the comparative effectiveness of the dusts and formaldehyde.

From his remembrance of the stand and smut records taken in June the grower reported that the 1 to 1 Arasan treatment controlled smut almost as well as formaldehyde but that there were some differences and that Arasan 1-4 was much inferior to formaldehyde. The yield records show that the stands were denser and the yields greater in the formaldehyde plots. Since temperatures were excessively high and precipitation deficient in 1944 the maximum beneficial influence of formaldehyde would be apparent in both smut and damping-off control.

In the plots for testing the effectiveness of Arasan at 1 to 4 for control of smut and damping-off in seedings for set production, the grower reported effective control of both diseases. The number of sets harvested in the treated rows was increased 83 percent over those in the check rows and in the untreated plots the thinner stands resulted in the production of bulbs too large for sets. There were no significant differences, however, in the total weights of the bulbs and sets in the treated and untreated plots.

1945 Experiments

(1) *WAHMHOFF FARM* — The experimental plantings in 1945 were made in Gun Swamp fields, the most important tests being conducted on the same farm as those of the two previous seasons. A new site was chosen about 10 rods from the area used in 1944. The preliminary tests in 1944 had given results which indicated that Arasan 1-4 might give satisfactory control of smut since it had been effective in those tests with the heavy seeding rates for set production. This dosage was reported by Gregory (2) as effective against smut in Indiana, the mixture being prepared in the drill at the time of seeding. He also reported that a 1-8 mixture was satisfactory, especially for set production. No enumeration data were given and no statement made as to the degree of soil infestation. The simplicity of this method and its applicability on the farm were appealing and it was decided to eliminate the pelleted seed from the 1945 trials and to test only this simplified treatment. The reports of Sproston and Boyd (5) from Massachusetts, as well as the writers experience with the lower dosages in 1944, provided a hopeful basis for the success of the 1-4 mix-

ture. A fungicide not previously tested in smut experiments, 8-hydroxyquinolin benzoate, but which has shown high fungicidal efficiency in laboratory tests, was used at the rate of 1-25.

The dusts and seeds were accurately weighed, mixed and placed in the drill just before seeding. A three-row drill attached to a walking type tractor was used. It was also equipped with a formaldehyde tank and discharge tubes. Two 42-rod rows were sown for each treatment and two rows were left untreated for controls. The variety used was Downing Yellow Globe. Formaldehyde 1-80, applied at the rate of 117 gallons to the acre, was the standard treatment for comparison. When the seedings were completed, the dust-seed mixtures remaining in the hoppers were removed and weighed so that the amounts of seed sown could be calculated. This was done so that adjustments could be made for differences in stand and yields because of the slightly different rates of seeding due to the various mixtures.

The seeding was done April 30 in soil so dry that it was being wind blown. Air temperature was below 50° F. Rain fell May 3 and frequently thereafter. The soil was excessively wet and abnormally cool for the three weeks following seeding. These conditions were responsible for delayed emergence of the seedlings and slow development

Fig. 3. Making smut counts in one of the blocks of the experimental plantings in Gun Swamp district, 1945. (1)—Two rows formaldehyde drip 1-80; (2)—No treatment; (3)—Arasan dust, 1-8; (4)—Arasan dust, 1-4; (5-6)—8-hydroxyquinolin benzoate 1-25; (7)—Arasan dust 1-8; (8)—Arasan dust 1-4. There is a denser stand of seedlings and the plants are further advanced in their development in the formaldehyde-treated rows. Wahmhoff farm, 1945.

of smut. They also prolonged the period of susceptibility to the disease, and the soil environment was favorable for infection. Delayed plant and smut development prevented the taking of disease records until June 29.

When the field records were taken, six sections of the experimental plots were selected at random and two rows exactly 16 feet long were measured and staked out in these sections for each of the treatments and check. The total number of plants in the two rows and the number infected with smut were determined by careful inspection. Each smutted plant was pulled as it was detected and every plant was examined by transmitted light (Fig. 3). Yield records were taken at the time of harvest. The data are in Table 2.

The mean percentage of infected plants in all of the rows planted with treated seed was lower than in those untreated but formaldehyde gave much superior protection against infection. Arasan 1 pound to 4 pounds of seed was the most effective dust treatment, but the mean percentage of smutted plants as a result of this treatment was more than 3 times that in the plots protected by formaldehyde. There were almost 6 times as many diseased seedlings in the rows treated with Arasan 1-8 as in those with the formaldehyde protection and this low dosage appears to be inadequate for the prevention of smut under soil conditions like those in this field. The 8-hydroxyquinolin benzoate dust at 1-25 gave very little protection against infection, and further tests at greatly increased dosage rates will be needed to determine its value as a smuticide.

Smut was held to a very low level by the formaldehyde treatment (Fig. 4B), only 2.31 percent of the seedlings were diseased and this is very satisfactory control under seasonal conditions like those in 1945 in soils with the degree of smut infestation such as that in the experimental plots. This demonstrates what may be expected of formaldehyde under soil conditions favorable for the disease. Since this efficiency has been repeatedly demonstrated under various soil conditions it can be accepted as a reliable index of its fungicidal action in the prevention of smut.

Significant differences between formaldehyde and the dust treatments were so apparent by inspection of the data that a mathematical analysis was not required for proof. Since the mean percentage of smut in the most effective dust treatment plots, Arasan 1-4, was more than 3 times that of the formaldehyde plots an analysis of variance was not needed to demonstrate the highly significant differences between the means of these treatments. An analysis was made however, to determine if there was such a difference between the means of Arasan 1-4 and Arasan 1-8. This analysis revealed a highly significant difference in favor of the heavier dosage with a value of 3.2 required

TABLE 2—*Comparisons of dust fungicides and liquid formaldehyde for control of onion smut, Orangeville, Michigan, 1945. Seedings April 30, disease records June 29, yields August 27, Wahmhoff farm.*

Treatment	Block I	Block II	Block III	Block IV	Block V	Block VI	Totals	Means of Totals	Means of Smut percent
Arasan 1-4	X*237	237	257	298	246	282	1,557	258.6	
	Y 25	30	21	16	16	11	119	19.8	**7.64
	Z 8.95	9.66	12.12	15.70	13.27	11.20	70.90	11.82	
Arasan 1-8	234	241	256	267	304	283	1,585	264.2	
	41	39	28	25	28	30	191	31.8	12.05
	8.32	8.91	10.14	15.5	12.07	9.78	64.72	10.79	
8-hydroxyquinolin benzoate 1-25	200	153	207	241	283	242	1,326	221	
	55	42	60	47	38	42	284	47.3	21.42
	4.35	6.02	9.50	11.71	10.87	9.07	51.52	8.59	
Formaldehyde 1-80—117 gallons per acre	365	299	315	297	337	289	1,902	317	
	21	8	7	1	4	3	44	7.33	2.31
	10.05	12.25	15.05	15.70	16.45	11.50	81.00	13.50	
No treatment	234	184	269	257	266	246	1,456	242.7	
	89	58	89	59	47	48	390	65	26.78
	4.02	5.38	9.75	12.72	11.75	8.56	52.18	8.69	

*X = Number plants in 16-foot row.
Y = Number smutted plants.
Z = Weight of bulbs in kgs.

**Least significant difference between means of Arasan treatments at 5% = 2.1; 1% = 3.2

at the 1-percent level and an actual difference of 4.38 shown by the means of the two treatments.

Yield data were of less value than disease records since rates of seeding were not uniform because of the influence of the dusts on volumes of the mixtures and on sowing rates. The comparative rates of seeding were determined by collecting and weighing the mixtures of dust and seed remaining in the hoppers. Since it is very difficult to adjust the apertures on the drills to discharge equal amounts of seed from each hopper, the drills were used as set by the grower for sowing untreated seed. His adjustments were such that each drill dropped as nearly equal numbers of seeds per lineal foot of row as could be done without very tedious and time-consuming adjustment tests. Since the rows were exactly the same length and the same number were planted with the mixtures of seed and dusts, the quantities sown could be determined by weighing the surplus in each hopper and subtracting this value from the initial weights. The quantities of seed sown from the three drills with the dust mixtures were as follows:

	Total seed sown	Pounds per acre
8-hydroxyquinolin benzoate 1-25	62.6 grams	3.72
Arasan 1-4	66.9 grams	3.75
Arasan 1-8	71.5 grams	4.24

The differences in the seeding rates resulting from the mixtures of seed and dust were significant only with Arasan 1-8 where the rate was slightly more than 13 percent in excess of that for the other two dust mixtures. The seeding rate of the untreated seed was approximately the same as that for the 1-25 mixture of 8-hydroxyquinolin benzoate since all of this dust adhered to the surface of the seed and did not measurably increase the volume for sowing. If a compensatory adjustment is made for stand differences due to differences in seeding rate, the stands in the Arasan 1-8 plots must be reduced 13 percent to make them comparable with those of the other plots. This would also result in an equal reduction in yield if we assume that the yield is in proportion to the stand which is a reasonable assumption for the treatments had no apparent effect upon time of emergence or subsequent growth rates. This adjustment would array the mean plot yields in the following order:

Formaldehyde 1-80	13.50 kilograms
Arasan 1-8	10.79 kilograms
Arasan 1-4	10.28 kilograms
No treatment	8.70 kilograms
8-hydroxyquinolin benzoate	8.59 kilograms

Yields of the formaldehyde plots are significantly higher than those of the dust treatments, but there are no significant differences between

TABLE 3—*Comparison of Arasan dust and liquid formaldehyde for control of onion smut, Orangeville Mich., 1945. Records June 20, from 3 16-ft. rows in each block for each treatment. Witherell Farm.*

Treatment	Block I	Block II	Block III	Block IV	Block V	Block VI	Totals	Means of	
								Totals	Smut percent
Arasan 1-4	X*309	247	258	264	287	282	1,647	274.5	
	Y 28	18	15	12	12	26	111	18.5	**6.74
Formaldehyde 1-72—100 gallons per acre	245	174	342	284	251	295	1,591	265.2	
	15	12	13	5	11	11	67	11.2	4.21
No treatment	128	129	266	245	206	262	1,236	206	
	68	62	123	82	64	89	488	81.3	39.48

*X = Number plants.

Y = Smutted plants.

**Least significant difference between Arasan and formaldehyde treatment means, 5%, 2.1

Fig. 4A. Comparison of formaldehyde-drip and Arasan dust treatments for the prevention of onion smut. (1)—Three rows treated with formaldehyde 1-72, 85 gallons per acre; (2)—Three rows, no treatment; (3)—Three rows treated with Arasan 1 pound to 4 pounds of seed in the drill at time of seeding. In the untreated rows smut killed almost one-half of the seedlings. Witherell farm, 1945.

Fig. 4B. Comparative effects of fungicidal treatments for the prevention of onion smut. (1)—Two rows treated with formaldehyde 1-80, 117 gallons per acre; (2)—One row, no treatment; (3)—One row Arasan dust 1 pound to 8 pounds of seed; (4)—One row Arasan dust 1 pound to 4 pounds of seed. The dust was added to the seed in the hopper at the time of sowing. Note denser stand and growth of seedlings in rows treated with formaldehyde. Wahmhoff farm, 1945.

the means of the two Arasan treatments. The 8-hydroxyquinolin benzoate treatment did not produce yields better than those in the untreated plots. The yield data thus conform well with the disease control data and demonstrate the complete superiority of formaldehyde in this field for the prevention of onion smut and the maturing of a maximum crop of marketable bulbs.

(2) *WITHERELL FARM*—This farm is one of the most heavily infested areas of muck land in Michigan. Failure to use formaldehyde invariably results in excessive smut infection (Fig. 4A). In 1945 the grower desired to compare the effectiveness of Arasan dust at the rate of 1 pound of dust on 4 pounds of seed with the standard formaldehyde method. The seedings were done with a three-row drill using Yellow Globe seed. Formaldehyde 1-72, was used at 85 gallons to the acre and three rows were left untreated. The rows were 80 rods long.

The records were taken June 29 on the same day as those in the Wahmhoff planting. Six 16-foot sections were staked out in the 80-rod plots and the total number of plants in each row and the number infected with smut were counted. Thus each plot count consisted of records from three rows treated with Arasan 1-4, three rows with formaldehyde 1-72 and three rows with no treatment. The data from these plots are summarized in Table 3.

In this field Arasan 1-4 was slightly more effective and formaldehyde slightly less so than in the experimental planting on the Wahmhoff farm. Nevertheless, the formaldehyde method gave a significantly lower percentage of smutted plants than the dust as shown by a statistical analysis of the differences of the smut percentages in each plot. Differences between the treatment means are significant at the 5-percent but not at the 1-percent level. Both treatments were effective however, in reducing smut losses to tolerable levels in contrast with the untreated rows where 39.48 percent of the plants were attacked by the disease (Fig. 4A). In this planting where treatments and seedings were done by a commercial grower formaldehyde again gave superior control of smut but the differences were less than those in the Wahmhoff field despite an apparently heavier soil infestation with the smut fungus.

(3) *McGUFFEY FARM*—This planting consisted of 85 acres of seedings spaced from April 13 to May 2. The varieties were White Globe, Yellow Globe and Michigan State College Sweet Spanish. All seedings were with 1 pound of Arasan to 4 pounds of seed mixed in the drill at the time of planting. No seedings with untreated seed nor with formaldehyde in the row were made so that data are not available for comparing the relative effectiveness of the standard treatment with

the dust and no treatment. From the disease counts made in various sections of the farm it seems apparent that soil infestation with the smut fungus is very light in comparison with that on the Wahmhoff and Witherell farms. Smut control was entirely satisfactory in plantings of all dates and with each of the varieties. Counts of total numbers of seedlings and those infected with smut were made in alternate rows of nine-row, 16-foot sections staked out in the various plantings. Thus the individual counts are those from five rows, 16 feet long. The records are as follows:

Field	Seeding date	Variety	Total number plants	Smutted	Percent smutted
1	April 13	White Globe	1,119	25	2.23
1	April 13	White Globe	1,183	28	2.48
2	April 20	Downing Yellow Globe	896	13	1.67
3	April 21	Downing Yellow Globe	845	8	0.95
4	May 2	Downing Yellow Globe	706	6	0.85
4	May 2	Downing Yellow Globe	710	7	0.99
5	May 2	Michigan State College Sweet Spanish	615	11	1.79
5	May 2	Michigan State College Sweet Spanish	526	7	1.33
Totals			6,500	107	mean—1.62

The various plantings in these fields were spaced over a period of 20 days and included soil conditions favorable and unfavorable for maximum development of smut. The earliest plantings were made when the soil was comparatively dry and warm as a result of unseasonably warm days which continued until April 18. Thereafter the soil was wet and cool and this provided a favorable environment for smut infection. The early seedings came up quickly and outgrew the period of susceptibility in a shorter time than those of April 20, 21 and May 2 which were exposed to soil conditions much more favorable for smut. It is interesting to note also that the stands in the early plantings were much more dense than in the later seedings. Since the early plantings were made with White Globe seed and the later ones with Yellow Globe and Sweet Spanish and no information was available on comparative germinabilities, these differences may have been due to differences in viability of the seed lots. Despite the very favorable soil conditions for infection smut did not develop in these fields in amounts comparable to those on the Wahmhoff and Witherell farms. Since no untreated sections were left for comparison the degree of soil infestation is unknown but it seems very probable that it is very light compared with that of other areas such as those of the Wahmhoff and Witherell fields. The grower stated that the stands and smut control in all fields in 1945 were superior to those he had obtained in any previous season with the formaldehyde treatment.

DISCUSSION

Smut is a major disease of the seeded onion crop in Michigan and its control is imperative if normal yields are to be obtained. There has been a recent increase in the acreage planted with sets and in these plantings the control of smut is no problem since they are immune. The major part of the Michigan crop, however, is grown from seed and smut is present in all of the older sections and is rapidly spreading to the newer districts. The practice of smut prevention is becoming more and more general throughout the onion districts of the state and only in those sections where the crop has been grown for a very short time can the seed be sown without the protection of formaldehyde. This method, while effective, is laborious and tedious and would be quickly discarded by onion growers if some other control method could be devised that would be simpler and less time-consuming in the busiest season of the year.

The experiments reported here with the dust treatments give some promise of providing a substitute method that eliminates most of the objections associated with standard control practices. These experiments have not given, however, the final answers to crucial questions that need to be answered before discarding a proved and effective method of control and using a radically different system. The Michigan onion crop is valued at several millions of dollars each year, and growers can ill afford to abandon a standard disease control method until an equally effective one has been devised and proved by extensive field experiments under various soil and seasonal conditions. The experiments with the dust fungicides have not been extensive enough nor of sufficient duration to provide information about their effectiveness under the varied climatic and soil conditions of Michigan. Many factors influence the development of onion smut, such as depth of planting, soil temperatures, soil moisture, soil type, and only numerous test plantings over a period of several years to include the action of these factors under various seasonal conditions will yield sufficient data from which sound recommendations can be made.

The question of the toxicity of the dusts to onion has not been settled. It has been observed that formaldehyde causes some delay in emergence and under some soil conditions causes serious injury to the seed. One of the objections to the use of formaldehyde has been the modifying influence of soil moisture upon its effectiveness and toxicity. In dry soils weaker solutions must be used than in wet soils and rains following within a shorter time than 24 hours after seeding will often reduce the effectiveness of even the stronger solutions. Dusts of low solubility, like Arasan, would be of great advantage since weather

conditions neither at the time of sowing nor subsequently would alter their effectiveness if they were not initially toxic to the seed and young plant. With low soil temperatures Arasan has been reported to cause some delay in emergence of pelleted seed but this is not necessarily solely a toxic effect. It may be partly mechanical by delaying the absorption of water required for germination. Experiments are now under way to obtain information of this nature.

These experiments and those in other states have indicated that Arasan or Thiosan at the heavy dosage rate of 1 pound on 1 pound of seed will give satisfactory control of smut under conditions of average soil infestation with the smut fungus. Some reports indicate that only formaldehyde is effective in soils where smut infestation is heavy. To apply these dusts at this dosage it is necessary to bind the dust to the seed. This is accomplished by wetting the seed with the Methocel sticker after which it will take up and hold large quantities of dust. If additional tests prove that 1 pound of dust to 1 pound of seed will be needed to give satisfactory control of smut some commercial source of seed pelleting will have to be available since individual growers will find it difficult to treat their seed. No special difficulties are anticipated in obtaining this service since pelleted sugar beet seed has been prepared on a commercial scale for Michigan growers and the same method could probably be adapted to the preparation of onion seed.

The growers questioned have indicated that the increased cost of the dust treatments, including custom charges for pelleting, would not tend to restrict the use of this method since the savings effected in time and labor would compensate for the additional cost. A reduction in the quantities of seed usually sown would also help to reduce the cost. These economies would equal at least the increased costs of the dust treatments over the formaldehyde. If further tests show that the dusts can be used effectively at a 1-2 or 1-4 rate then the cost might be even less than that of formaldehyde. The material costs would be about the same and the savings in labor and valuable time when time is a critical factor during seeding because of uncertain weather conditions, would make the intangible benefits from use of the dusts more valuable than the costs of the materials.

The dusts tested will not drill satisfactorily in mixtures where the ratio of dust to seed is less than 1-4. The 1-4 mixture represents the heaviest dosage of dust that can be mixed with the seed in the drill and give satisfactory seeding results. Decreasing the ratio to 1-3 or 1-2 will result in a plugging of the drill apertures. New types of drill plates would have to be developed to give an even seeding of the unpelleted seed at these heavier dosages. Further tests, however, might result

in the preparation of mixtures with conditioning agents that would readily pass through the drills.

With the limited amount of information available about the dust treatments and the lack of uniformity in the experimental results obtained in Michigan it is not recommended that onion growers abandon the formaldehyde treatment unless further trials demonstrate the safety and effectiveness of the dust method. In sections where smut has been present for several years and on fields where it has been necessary to use formaldehyde to prevent the development of excessive amounts of smut, the standard treatment should still be applied. On these farms tests should be made to compare the degree of smut control with the two methods. A trial planting of ¼ pound of dust mixed in the drill at the time of seeding with 1 pound of seed could be made in the fields where smut causes the most injury. If three-row drills are used one row could be seeded with the dust-seed mixture, the adjacent row with the formaldehyde treatment and the third row left untreated for a control. Several of these strip plantings should be made in the field and it would be well to make them concurrently with the usual plantings. They should be spaced so that the several plantings are made from one week to 10 days apart. If this is done by a number of onion growers in each district where smut occurs a mass of information will be obtained in 1946 that will give a sound basis for recommendations and conclusions as to the comparative effectiveness of the two methods.

The dust treatments can be used where smut is not present and will increase the stands by preventing much of the damping-off that thins the stands before and after emergence of the seedlings. For damping-off alone 1 pound of dust mixed with 8-10 pounds of seed will be sufficient. With this mixture and seed of high viability not more than 3½-4 pounds per acre should be sown at the usual spacing of 14 inches.

SUMMARY

Smut is one of the major diseases of the seeded onion crop in Michigan. It occurs in most of the important onion districts and its range is constantly increasing.

The standard method of smut prevention consists of applying a dilute solution of formaldehyde in the row with the seed. Though very effective this method is objectionable to practical onion growers because it is laborious and time-consuming when rapid planting is essential.

Experiments were conducted for three seasons with dust fungicides to compare their effectiveness with the standard method. They were either mixed in the drill with the seed or stuck to it with special bind-

ing materials. Dusts containing tetramethyl thiuramdisulphide (Arasan, Thiosan) have been tested at ratios of 1-1, 1-4, 1-8 and 1-25.

Evidence from these experiments, while inconclusive, indicates that dusts are neither superior nor equal in effectiveness to the standard formaldehyde method for the control of smut in soils with moderate to heavy degree of soil infestation with the smut fungus. In some commercial plantings where soil infestation apparently is light they have given adequate control.

In small-scale trials Arasan 1 pound mixed with 4 pounds of seed has given satisfactory control of smut in the heavy seedings for set production.

Until additional tests are completed Michigan onion farmers are urged to try the dust treatment on an experimental scale only in 1946 and to use formaldehyde for the main plantings.

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The writer is indebted to Mr. George Wahmhoff, Doster, Mich., on whose farm some of the experiments were conducted, for assistance in planting, taking records and harvesting the bulbs from the experimental plots.

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JOURNAL ARTICLE ABSTRACTS

The Effect of Fertilizer and the Age of Plants on the Quality of Alfalfa and Sweet Clover for Green Manure

DAVIS, J. F. AND TURK, L. M.

Proc. Soil Sci. Soc. Amer. 8: 298-303. 1944. [*Journal Article 668 (n.s.) from the Michigan Agricultural Experiment Station*]

Replicated samples of tops and roots of alfalfa and sweet clover grown on Brookston Clay loam soil were harvested on four different dates and were taken from plots heavily fertilized, moderately fertilized, and from plots receiving no fertilizer. Samples were also taken from areas receiving the same application of fertilizer but from plants of different ages.

The following determinations on the samples were made: oven-dry weight of both tops and roots; content of N, P_2O_5, K_2O, CaO and MgO; rate of decomposition under laboratory conditions; and their effect, when used for green manures, on the growth of proso in the greenhouse.

Alfalfa fertilized with 1,000 pounds of 0-12-12 fertilizer had a higher content (in both tops and roots) of P_2O_5, K_2O and N than that which was unfertilized but no difference was found in the percentages of CaO or MgO.

As the amount of N and P_2O_5 increased in the tops with advancing maturity, a corresponding decrease occurred in the roots. The only significant increase occurring in the combined chemical composition of the tops and roots with advancing maturity was in the content of CaO and K_2O.

Three-year-old alfalfa yielded 1,174 pounds more roots and had a total of 6.5, 21.2 and 10.2 pounds more of K_2O, CaO and N per acre, respectively, and 9.0 pounds less of P_2O_5 than two-year-old alfalfa.

The percentages of P_2O_5 and K_2O in tops and roots and the percentage N in the tops were higher in alfalfa seeded with barley than in alfalfa seeded in wheat.

With increased top growth of sweet clover, there was a decrease in the weight of roots and percentage of N and P_2O_5 in the roots, and a decrease in the percentages of N, P_2O_5 and K_2O in the tops. The total amount of K_2O, CaO and MgO contained in the combined tops and roots progressively increased with the growing season, but no appreci-

able change occurred in the P_2O_5 content. Fertilizer increased the percentages of P_2O_5 and N in the tops and roots of sweet clover, the percentage of CaO was lowered, and there was no significant effect on the MgO or K_2O percentages.

Alfalfa and sweet clover grown on fertilized soil produced greater increased yields of proso in the greenhouse than the unfertilized crops when used for green manure. Ammonification and nitrification of fertilized alfalfa and sweet clover were more rapid than that which was not fertilized.

Evidence is presented to indicate that the superiority of sweet clover in comparison with alfalfa green manure under field conditions can be attributed to the higher percentage of nitrogen in sweet clover and to its more rapid rate of nitrification.

The Bactericidal Action of Bovine Blood for Brucella and Its Possible Significance

HUDDLESON, I. F., WOOD, E. E., CRESSMAN, A. R., AND BENNETT, G. R.

Jour. Bact. 50 (3): 261-277. 1945. [*Journal Article 578 (n. s.) from the Michigan Agricultural Experiment Station*]

It is pointed out that several factors influenced the result of an *in vitro* test for measuring the bactericidal action of bovine blood for *Brucella*. Blood plasma from normal calves and cows possesses a complex which kills large numbers of *Brucella abortus in vitro*. Serum possesses the same property, but to a lesser extent. The bactericidal complex does not make its appearance in calf blood to any extent until after the ingestion of colostrum. Blood plasma from cows infected with *Brucella abortus* possesses a property which inhibits the killing action of the bactericidal complex for *Brucella*. *Brucella*-infected cows may be detected and distinguished from those not infected by making use of differences shown in the bactericidal action of their plasma for *Brucella*. The serial dilution method reveals greater differences in the bacteria-growth-inhibiting action of plasma from normal and *Brucella*-immune cows. Such differences suggest that specific bactericidal antibodies, if present in sufficient concentration, play an important role in the protection of cattle against brucellosis.

Poikilocytosis in Dairy Cattle

REID, J. T., HUFFMAN, C. F., AND DUNCAN, C. W.

Arch. Path. 39: 351-357. 1945. [*Journal Article 739 (n. s.) from the Michigan Agricultural Experiment Station*]

The occurrence and symptoms of poikilocytosis among dairy cattle ranging from young calves to mature cows was studied. The distribu-

tion of poikilocytes among the 233 affected animals varied up to more than 90 percent of the red corpuscles.

The health of the animals whose blood showed 50 percent or more of the total red corpuscles to be poikilocytic (abnormally shaped) was usually subnormal. Lack of appetite was the outstanding symptom that accompanied the high incidence of poikilocytosis. In some instances, however, depraved appetite was manifested by the animal's chewing of wood. Other symptoms shown by affected animals were general thinness and roughness. The hair was long and shaggy and had a hard, dry appearance.

Poikilocytosis in dairy cattle was independent of the hemoglobin content, the number and volume of red blood cells and the calcium inorganic phosphorus and magnesium.

A Rapid Laboratory Method for the Detection of Manganese in Fresh Plant Tissue

COOK, R. L. AND LAWTON, KIRK

Soil Science Soc. Amer. Proc. 8: 327-328. 1943. [*Journal Article 678 (n. s.) from the Michigan Agricultural Experiment Station*]

Some of the alkaline soils of Michigan are deficient in manganese for certain crops. Characteristic symptoms of deficiency develop on the plants when the supply of available soil manganese becomes too low. Using these symptoms, established by field and pot tests, as a measure of the amount of manganese in the plants, a colorimetric method of determining manganese in fresh plant tissue was developed. It was found necessary to establish a color range for each crop studied.

Manganese was extracted from the fresh leaf tissue by shaking in 1-33 acetic acid and filtering. It was then oxidized by periodate in the presence of nitric acid and phosphoric acid. Solutions were boiled exactly 30 seconds. The colors, ranging from colorless or yellow to strong orange developed on cooling. A color table describes the range of colors for each crop.

The Effect of Some Environmental Factors on the Set of Pods and Yield of White Pea Beans

DAVIS, J. F.

Jour. Agr. Res. 70 (7): 237-249. 1945. [*Journal Article 671 (n. s.) from the Michigan Agricultural Experiment Station*]

Investigations on the effect of temperature, humidity, soil moisture, leaf area and fertilizer on the behavior of the Michelite variety of white pea bean *(Phaseolus vulgaris L.)* were carried out both in the green-

house and in the field for a three-year period, 1939-41. The field experiments were located in Clinton and Tuscola counties.

The data indicated that maximum temperature during the blossoming season influences the set of pods more than any of the other factors studied and that the percentage sets of pods can be predicted from maximum temperature with a fair degree of accuracy. Minimum relative humidity and soil moisture within the limits encountered in the work, exert only a minor influence on the set of pods. The relation of leaf area to yield of beans may range from a positive to a negative correlation depending on the weather prevailing during the blooming period. The yield of beans, therefore, cannot be safely predicted from leaf area. Fertilizer had no effect on the set of pods. The results from this study should explain in a number of cases the reason why the increase in the vegetative growth of the plant caused from an application of commercial fertilizer is not reflected in an increase in yield of the crop. If unfavorable weather conditions are present during the blooming period a poor set of pods may result.

A study of this nature is valuable in determining what areas may be best suited for crops that, like the white pea bean, have critical environmental requirements.

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